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PUBLISHED UNDER THE AUSPICES

OF THE

MADRAS LITERARY SOCIETY

AND

AUXILIARY OF THE ROYAL ASIATIC SOCIETY.

VOL. XII.

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CONTENTS.

Page.

I.—Catalogue of the Birds of the Peninsula of India, arranged according to the modern system of Classification; with brief Notes on their Habits and Geographical Distribution, and description of new, doubtful and imperfectly described Species (*Continued*).—By T. C. JERDON, Assistant Surgeon, 2d Madras Light Cavalry.................... 1

II.—List of Minerals for presentation to the Society, collected from various parts of the Nizam's territories, Ceded Districts, Kurnool, the Southern Mahratta Country, Mysore, &c.—By Lieut. T. J. NEWBOLD, 23d Light Infantry....... 16

III.—Remarks upon the Auriferous Deposits of India, considered with especial Reference to their Economical Value.—By FREDERICK BURR, Esq.................................. 30

IV.—Observations on the Fossiliferous beds near Pondicherry, and in the district of South Arcot.—By C. T. KAYE, Esq. Madras Civil Service.................................. 37

V.—Remarks on the Fruit of the Natural Order Cucurbitaceæ.—By ROBERT WIGHT, M. D., F. L. S., &c..................... 43

VI.—Notices of some Roman Catholic Books, existing in the Telugu Language.—By C. P. BROWN, Esq. 54

VII.—On the Fossils of the Eastern Portion of the Great Basaltic District of India.—By JOHN G. MALCOLMSON, Esq., F. G. S. 58

VIII.—On the Entomology of the Himalayas and of India.—By the REV. F. W. HOPE, F. R. S., F. L. S., &c., President of the Entomological Society of London.................... 105

IX.—Memoir on the Mammalogy of the Himalayas.—By WM. OGILBY, Esq. M. A., Fellow of the Royal Astronomical, Geo-

Page.

logical, Linnæan, and Statistical Societies; Secretary of the Zoological Society..... 139

X.—Beryl Mine of Paddioor, and Geognostic Position of this Gem, in Coimbatoor, Southern India.—By Lieutenant NEWBOLD, Madras Army, A. D. C. to Brigadier-General WILSON, C. B 171

XI.—On the Functions of the Colouring Matter of the Skin in the Dark Races of Mankind.—By ROBERT MORTIMER GLOVER, M.D., Lecturer on Chemistry in the Newcastle-on-Tyne School of Medicine.......................... 175

XII.—Proceedings of the Madras Literary Society and Auxiliary of the Royal Asiatic Society.............. 181

XIII.—Meteorology

Horary Meteorological Observations made agreeably with the suggestions of SIR JOHN HERSCHEL.................. 187

Meteorological Register kept at the Madras Observatory; for the months of April, May and June 1840. 189

CONTENTS.

Page.

Art. I.—Catalogue of the Birds of the Peninsula of India, arranged according to the modern system of Classification; with brief Notes on their Habits and Geographical Distribution, and description of new, doubtful and imperfectly described Species.—By T. C. Jerdon, Assistaunt Surgeon, 2d Madras Light Cavalry 193

II.—On the General Application of Low Steam Power to all Vessels, instead of Sails 227

III.—On the Separation of the Pomegranate as a distinct Natural Order from Myrtaceæ. (With a Plate.)—By Robert Wight, m. d., &c 254

IV.—On the Construction and use of Portable Barometers.—By Captain J. Campbell, Assistant Surveyor General 261

V.—Account of the Basava Puran;—the principal Book used as a religious Code by the Jangams.—By C. P. Brown, Esq 271

VI.—On the Structure of the Sevalik Hills and the Organic Remains found in them.—By Proby T. Cautley, Esq. Captain Bengal Artillery, F. G. S 292

VII.—Notice on the Remains of a Fossil Monkey from the Tertiary Strata of the Sewalik Hills in the North of Hindoostan.—By Captain P. T. Cautley, F. G. S., Bengal Artillery; and H. Falconer, Esq., M. D., Bengal Medical Service 304

VIII.—Memoir on the Geology of Cutch.—By C. W. Grant, Erq., Captain Bombay Engineers 309

Page.

IX.—On certain Meteorological Phænomena in the Ghats of Western India.—By Colonel SYKES, F. R. S. 371

X.—Proceedings of the Madras Literary Society and Auxiliary of the Royal Asiatic Society........... 374

XI.—Meteorology

Horary Meteorological Observations made agreeably with the suggestions of SIR JOHN HERSCHEL...... 376

Meteorological Register kept at the Madras Observatory; for the months of July, August and September 1840......... 378

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(*Continued from No.* 27, *page* 239.)

Ord. III.—RASORES, Ill. Swains.—*Game Birds* and *Pigeons.*

Family PAVONIDÆ.

Genus PAVO, L.—*Peacock.*

265.—*P. cristatus*, L.—*Mohr*, H. and Mah.—*Common Peafowl.*

The *Peafowl* abounds in most of the wooded districts of India, and also in woody nullahs, and low jungle in various parts of the country. It breeds most usually towards the end of the monsoon.

Genus GALLUS, Briss.

266.—*G. Sonneratii*, Temm.—*Junglee Moorgh*, H.—*Common Jungle Fowl.*

This *Jungle Fowl* is tolerably abundant in most of the lofty jungles of the South of India, and is also found in the lower jungle in the Carnatic and eastern range of ghauts. It is not, however, met with in the Northern Circars. It is very partial to bamboo jungle. I once found the eggs of this fowl, seven in number, on the ground in dense jungle at the foot of the Neilgherries. They were of a light pinkish cream colour.

267.—*G. Bankiva*, Temm.—*Red Jungle Fowl.*

This species, hardly distinguishable in appearance from many of the domestic varieties, and unquestionably the origin of most of the varieties of our common fowls, is the only jungle fowl found in the woods of the eastern ghauts in the Northern Division, and is very abundant in some parts, as in Goomsoor. I do not know exactly how far south this species extends, but know that it is found as low as Cummum, N. L. 16°. The crow of this bird is much more distinct and marked than that of the last one, which has only a broken and very indistinct call.

Family TETRAONIDÆ.

Genus ORTYGIS, Ill. Swains.—*Hemipodius*, Temm.—*Three-toed Quail.*

268.—*O. pugnax.*—*Hemip. pugnax.*, Temm. P. C. 60-2.—*Tetrao nigricollis* and *Madagascariensis* of the older authors?—*Gooloo*, H. in the South of India.—*Toorah* of others.—*Black throated three-toed Quail.*

This pretty species is tolerably common in most of the well cultivated parts of India, frequenting low jungle, and also fields of pulse, chillee, &c. It is sometimes found solitary, often in pairs, but also in bevies of 5, 6 or 7. It feeds on various grains and seeds, also much upon insects, especially white ants, and the larvæ of grasshoppers, &c.

Colonel Sykes and M. Temminck assert the identity of the plumage of both sexes, and though I did not examine them when I shot several in company, they were always clothed alike.

This bird is often caught and caged by the Mussulmauns of Southern India. It has a peculiarly loud purring call, and this is made use of to ensnare others in the following manner. The female is taken into the jungle in a small cage, chiefly during the breeding season, which is said to be (in the Carnatic) about the end of the monsoon. The cage has a small plank in front of the bars, over which an arched cover is made to fall by the snapping of some thread, placed between the bars. It is then placed on the ground in a low bush and partially concealed by leaves, &c. The bird within begins its loud purring, and any of its kind in the neighbourhood run rapidly to the spot, and commence pecking at the bars of the cage—this soon breaks the thread, and the spring cover falls, ringing a small bell at the same time, by which the owner, who remains concealed, is warned of a capture—15 or 20 are occasionally caught in this way in a single day.

Irides light yellow; bill and legs dull bluish. Length $6\frac{1}{2}$ inches; wing nearly $3\frac{1}{2}$; tarsus $\frac{8}{10}$ths; bill to front $\frac{1}{2}$ inch; weight about 2 oz. 1 dr.

268, *Bis.—O. Taigoor*, Sykes; figured Trans. Zool. Soc. vol. 2.

From the few opportunities I have had of observing this bird, I am inclined to agree with Colonel Sykes, and place it as a distinct species. I have only procured it solitary, in long grass on the more open spaces of the forests of the Western Coast. Bill bluish, with a tinge of yellow beneath. Irides pale yellow. Length 6 to $6\frac{1}{4}$ inches; wing 3; tarsus fully $\frac{8}{10}$ths; bill rather shorter and less high than in the preceding species.

269.—*O. Dussumierii.—Hemip. Dussumierii*, Temm. P. C.—*Toorah*, H.—*Smallest three-toed Quail.—Button Quail* of some Europeans.

This very small bird, probably one of the least of the order, is always found solitary, generally in long grass, sometimes in the fields of pulse. It is flushed with difficulty, and, as Colonel Sykes remarks, its flight is abrupt and short. Irides pale yellow; bill dusky; legs whitish flesh-coloured. Length $5\frac{1}{2}$ inches; wing nearly 3; tarsus $\frac{7}{10}$ths; bill front $\frac{4}{10}$ths.

Gen. TETRAO.

Sub-gen. PTEROCLES, Temm.—*Rock*, or *Whistling Grouse*.

270.—*P. exustus*, Temm. P. C.—354 and 360.—*Bur-Teetur*, H.—*Common Whistling Grouse.—Rock Pigeon* of Europeans.

This is a very common and abundant bird in most parts of the open country. It is not found in wooded districts. It associates in parties

varying in number from 4 or 5 to 50, or even more, and frequents the open stony plains, and bare fields. It flies swiftly, and generally at a considerable height, and as Colonel Sykes has remarked "has a most peculiar and piercing cry which often announces its approach ere it is observed." It feeds chiefly on a very hard kind of seed. When approached it often squats close, and it is very difficult to distinguish it in some pieces of ground. After its morning meal it always goes to some neighbouring water to drink. Its flesh, which is brown and white, is remarkably hard and tough, and will keep longer than that of any other game bird; this hardness causes it to be less appreciated than it deserves to be, for, when kept a sufficient time and well dressed, it has an excellent flavour, inferior to very few of the Indian game birds.

I have found its eggs several times lately in the months of January and February, placed on the ground without any nest, 3 in number and of light olive greenish hue, speckled with olive brown and dusky, of a very long shape, and equally rounded at both ends.

Length about 13 or 14 inches; wing 7; tail (centre feather) 5; weight of male about 9 oz.; bill, legs, and naked skin round eye, cinereous.

271.—*P. quadricinctus*, Temm.—*Tetrao Indicus* of Gmelin.—*Hundeyree*, H.—*Painted Whistling Grouse* or *Rock pigeon.*

This richly plumaged *rock grouse*, is much more rare than the last, and unlike it is neither gregarious nor found in the open plains. It lives in pairs, and frequents bushy plains, and stony and jungly hills. It flies but a short distance, and its cry, which is of the same character as that of its congener, though much less loud, and deeper, is never heard except when the birds are first flushed.

I have lately got the eggs of this species, also, very similar to the other, bu rather smaller, and with the spots fewer and larger.

Irides deep brown; bill red; naked skin round eye, lemon yellow with a green tinge; feet ochre yellow; claws reddish. Length 10 inches; wing $7\frac{1}{4}$; tail 3; weight of cock bird about 7 oz.

Gen. PERDIX.—*Partridge.*

272.—*P. picta*, Jard. and Selby, Ill. Ornith.—*P. Hepburnii*, Gray and Hardw., Ill. Ind. Zool.—*Kala Teetur*, H.—*Painted Partridge.*

The painted *Partridge* is not found in the Carnatic, nor in the Malabar Coast, and I believe not in the more southern portion of the table land. It begins to be met with first in any quantity about N. lat. 15°, in the neighbourhood of Bellary, and becomes more numerous as you advance towards the north. It frequents both low bushy jungle

and grain-fields, especially those of wheat, and also long grass by the sides of rivers, water-courses and elsewhere. The cock bird has a most peculiar crowing note, which though not very loud, is yet heard a long way off. It may be heard morning and evening uttering this croak, generally seen to do so whilst perched on a bush. Mr. Elliot says well on this subject—"Its peculiar cry may be expressed by the syllables *Chē-kĕ-kĕrrēy*, pronounced very gutturally. The poults chirrup like crickets" The *painted Partridge* is not found in coveys, generally single or in pairs. It breeds during the monsoon, lays 6 or 7 eggs of a smoky bluish white colour, of an oval form, much depressed at the thick end. It is not held in very high esteem for the table. Bill blackish; irides brown; legs yellowish red. Length about 12 inches; tarsus $1\frac{7}{10}$ths; weight of male about 11 oz.

Sub Genus FRANCOLINUS.—*Spurred Partridges.*

273.—*F. Ponticerianus,—Perd. Orientalis*, Gray and Hardw., Ill. Ind. Zool.—*Teetur*, H.—*Common Partridge* of India—*Scavenger Partridge* of some.

The common *Partridge* is found in every part of the peninsula, both in bushy ground, and more especially in cultivated lands, fields and gardens, delighting in the hedge rows. It perches freely even during the day. The cock bird has a most peculiarly loud and piercing call. It is often caught and tamed by the natives, and becomes most familiar, following its owner like a dog and uttering its loud call, when whistled or spoken to. It is also much used for fighting, which it does with great courage and spirit. Its flesh is held in no esteem by Europeans. It breeds towards the end of the monsoon, and in the cold weather. An opinion prevails among the natives, that the partridge lives for seven years, and is then changed into a Cobra di capella!

274.—*F. Spadiceus.—Perd. Spadiceus*, Lath.—*Spur-fowl* of Europeans in India.

Unlike the last species, the *spur-fowl* is only found in the denser jungles, as well as of the Eastern as of the Western Coast, and generally along with the *Jungle fowl*. It is found in the low brushwood of the lofty forests, and when flushed, as it is with difficulty, frequently perches on the bough of some lofty tree. It is generally found in pairs, and feeds on various seeds and insects. I found the craws of some crammed with insects alone, among which various species of *Cimices* were the most predominant. Its flesh is excellent and of very high flavour. It is found on the top of the Neilgherries in the dense woods there. The

female has been well described by Colonel Sykes. The natives generally consider this bird as more allied to the *jungle fowls* than to the partridges, and it is said to run with its tail elevated.

Bill, naked skin round eye, and legs red. Length 14-15 inches; of which the tail is about 5.

Sub-Genus COTURNIX, Briss.—*Quails.*

275.—*C. Dactylisonans.*—*Ghaghus*, H.—*Large grey Quail* or *Deccany Quail.*

The quail of Europe is by no means common in most parts of the peninsula, and certainly appears in greatest abundance during the cold weather, though according to Sykes and others, it remains and breeds here during the monsoon. It is found generally in long grass by the sides of rivers, tanks, and nullahs, or among the grain-fields, and generally in pairs.

Length 7½ to 8 inches. Average weight about 4½ oz.; bill dusky brown; irides light brown; legs flesh-coloured.

276.—*C. Textilis*, Temm.—*Perd. Coromandelica*, Lath.—*P. olivacea*, Buch.—*Batteir*, H.—*Black breasted Quail.*—*Rain quail* of some.

This pretty little species is very common in most of the well cultivated districts of India, frequenting the fields in bevies, and also patches of grass in various situations, and low jungle. It breeds during the monsoon; many natives consider it as the male of the last. Irides reddish brown; bill horny brown.

Length 6—6½ inches; weight about 2½ oz.

277.—*C. argoondah*, Sykes.—*Perd. Cambayensis*, Auct.?—*Lewah*, H. —*Rock Quail*—*Bush Quail* of some.

The common rock quail is exceedingly abundant in every part of India, frequenting bushy and stony ground, and also the neighbouring grain-fields in considerable bevies. It is much used by the natives for fighting, which it does with great spirit and obstinacy.

Irides reddish brown; bill dusky blackish; legs red. Length 6—6½ inches.

278. *C. pentah*, Sykes—*Perd. rubiginosa*, Valenc.—*Geerzah*, H.—*Forest quail.*

I fully agree with Col. Sykes in separating this species from the last, from my own observations, its different habitat, and the testimony of all the quail fanciers of Southern India, who will at once point out a

Geerzah among a lot of '*Lowahs*'. It is an inhabitant of all the forests of S. India, and also occasionally and more sparingly found in low jungles, and wooded nullahs in the Carnatic and other regions. It is found at all levels, from the neighbourhood of the sea to the summits of the lofty mountains of the Western Ghauts. The *Geerzah*, though also caught and used for fighting, is in less esteem than the *Lowah*. Irides brown; bill dusky; legs reddish yellow. Length 6½—6¾ inches.

279.—*C. erythrorhyncha*, Sykes.—*Koknee Lowah*, H.—*Red-billed Quail.—Black quail* of the Neilgherries.

This very handsomely plumaged quail is very abundant on the top of the Neilgherries, frequenting the low brushwood of the woods, and occasionally entering gardens. As it is mentioned by Colonel Sykes and also by Mr. Elliot, in his Catalogue, it is probably to be found in all the more elevated districts of the Western Ghauts.

Bill and legs fine red; irides brown. Length 6½; weight about 2¾ oz.

280.—*C. Chinensis.—Perd. Chinensis*, Auct.

There is an accurate description of this species of quail in Mr. Elliot's notes, taken from a single specimen, shot by a gentleman near Belgaum in the Southern Mahratta Country.

Fam. TRUTHIONIDÆ.

Gen. OTIS, L.

281.—*O. nigriceps*, Vigors—Gould Cent. Him. Birds.—*O. Edwardsii*, Gray and Hardw., Ill. Ind. Zool.—*Tokdar*, H.—*Black-headed* or *Indian Bustard.*

This noble bird is found, I believe, over all the peninsula, except perhaps on the wooded regions of the Western Coast, but more numerous in some localities than in others. Wherever there are extensive plains, whether of long grass or cultivated, this bird is most abundant, more especially on the trap formation of the north-west part of the great table land. The *Bustard* is frequently seen alone, occasionally 2, 3 or 4 together, and often flocks of 20 or more are seen feeding in company. Its most favourite food is large locusts and grasshoppers, also the common black and red *mylabris*, various insects of the genus *buprestis*, *scarabæus* and others, caterpillars, centipedes, and even lizards. Mr. Elliot mentions a quail's egg entire having been found in the stomach of one. In

default of insect food, it eats various fruit, grains and seeds, especially the fruit of the *Ber* (*Zizyphus Jujuba*). Several small stones are generally found in the stomach, and I once found some large fragments of a brass bangle in one.

The *Bustard* breeds most generally about the end of the monsoon, and subsequent cold weather, the female laying one or two eggs; it, however, varies much in the time of breeding. The egg is of a dark olive colour, with obscure darker blotches. When feeding, it is generally wary and difficult to approach, but during the heat of the day it lies down either in the long grass, or in the shade of some bush, and is then often approached quite close. It usually takes a long flight when once raised, often several miles, and flies with a continued flapping of its wings, never sailing.

The *Bustard* has a loud hoarse call, by some compared to a bark or a bellow, this is rarely heard however, except when the bird is alarmed. It has, however, another cry, as I learn from Mr. Elliot's notes, which is probably the call to its mate. I extract Mr. Elliot's note on the subject. "October 12th, killed a large *cock bustard*. When first seen he was making a curious noise, like a person in pain moaning, which was heard at a considerable distance. I at first thought it proceeded from some one in distress, and rode towards the spot under that impression, until I saw the *bustard*. He was strutting about on some high ground, expanding his tail, ruffling his wings, and distending his neck and throat, making the feathers stand out like a ruff. I frequently afterwards heard the moaning, always at the same season."

The gular pouch of the cock bird can contain three quarts of water and more.

Length of male 4½ feet; wing 30 inch; tail 13; tarsus 8½; bill (front) 3; expansion of wings nearly 8 feet; weighs sometimes 25 or 26-lbs. The female is about a third less and measures about 3½ feet in length.

282.—*O. aurita*, Lath., Jard. and Selby, Ill. Orn.—*O. fulva*, Sykes.—probably also *O. Indica*, Auct.—*Churz*, H.—*Tan-mor*, Mahr.—*Kunnowl*, Can.—*Florikin* and *Black Florikin*.

It is still a disputed point among naturalists and sportsmen whether the *black florikin* be a distinct species from the common one, or not—and the only two writers on Indian Ornithology who have observed the bird in its native haunts, viz. Major Franklin, and Colonel Sykes, have pronounced it to be a distinct species. From the synonymes I have adopted, it will be seen that I consider them identical, and from my own observations I have concluded that the *black florikin* is the cock bird, in its summer or breeding plumage *only*, Colonel Sykes having

accurately described its winter dress as being almost identical with that of the female. I may here state that there are two other opinions prevalent in India on this subject. One is that the *black florikin* is the young bird, and that he *changes* to the livery of the female; the other is that he is the adult cock bird, but that he does not change his plumage. The following are the chief reasons I have for considering the *black florikin* as the nuptial plumage of the common or *fulvous florikin.*

1st. All *black florikin* examined by me (and others, I believe,) have been males.

2d. The *black florikin agrees exactly* with the characters of the *male* of the *O. fulva*, as described by Sykes, in size, length of wing, and acumination of the quill feathers—the points of difference from the female.

3d. The time of the first appearance of the black plumage of the *florikin* corresponds with the era preceding the breeding season—and its disappearance also coincides with the termination of the breeding season; and I have seen specimens in all states of progressive change, from the female garb to that of the perfect *black florikin*, and again from this, their nuptial plumage, to the more sober livery of the rest of the year.

4th. No males in the grey or fulvous plumage, in which at least some black feathers were not visible, were ever shot by me during the breeding or summer season, i. e. from June to November.

5th. I may cite the evidence of Lieutenant Foljambes, in a brief paper in the Journal of the Asiatic Society of Bengal, in which he states it as his belief 'that they are the same bird, but that the black one is only met with in Guzrat during the monsoon,' i. e. the breeding season.

Lastly—I may state that several successful sportsmen, to whom I have lately mentioned my opinion on this subject, fully agreed with me, and even the opinion of those who considered the black birds to be young ones, is, I think, to be added to the testimony in favour of the black being the breeding plumage of the male bird.

In the neighbourhood of Jaulnah, where my observations have been chiefly made, I have seen the male bird just commencing to assume the black plumage early in May, and I believe the majority of them have assumed the perfect black plumage by the beginning of August. By the middle of November most of them have, with the exception of a few stray feathers, occasionally re-assumed their more sober grey livery. I am perfectly aware that there are many occasional exceptions to this; dependent, however, I am convinced, chiefly on the well known great irregularity of the time of breeding, so common in hot countries, where the birds are not compelled, as they are in a cold country, to limit

their season of breeding to an odd month or two : and also partly on the fact hereafter mentioned of many pairs breeding, especially towards the south of the peninsula, after the great annual immigration in October and November.

The most general time of breeding of the *florikin* about Jaulnah, is the months of August and September. Birds have, however, been flushed from their eggs as late as October. During this season the females are remarkably shy and wary, and flushed with difficulty, and during the whole monsoon, cock birds, either in a state of change, or in the perfect black plumage, are almost the only ones to be met with. I am informed by native sportsmen that the black bird is occasionally seen in company with the hen at this time, or walking round her whilst sitting on her eggs, yet I think it probable that the cock birds withdraw from the society of the hens soon after incubation has commenced.

Though a few couple remain in most parts of the country, for the whole year, and breed, yet the great body of them undoubtedly migrate to the peninsula at the beginning of the cold weather in October, and remain till March or April, when they emigrate for the purpose of breeding. As before mentioned, after their arrival, several couples undoubtedly breed, sometimes as late as December and January, especially in the Carnatic, the Northern Circars, and Mysore. I believe, however, that the great majority of them do not breed after their arrival in the south, and that such as do are probably the ones bred late in the south of the peninsula the previous year, and which were not sufficiently matured to do so along with the others, in the early monsoon season of Upper India. In the Carnatic, as about Trichinopoly, at the commencement of the season in October, a considerable number of those brought in by the native shikarees are black, chiefly, however, in a state of change from the perfect plumage—they leave this district in February.

I am informed that in the Nellore and Guntoor districts, both the most celebrated *florikin* grounds in Southern India, the *florikin* do not arrive in any numbers till November, and black birds are hardly ever met with. This, I may remark, is an additional proof in favour of my opinion. A few couple, most probably, remain even here, in the wilder and more sequestered parts, for I have heard of a *black florikin* being killed in the Tinnevelly district in the month of August. In the Southern Mahratta Country, as I learn from Mr. Elliot's notes, the *florikin* arrive towards the end of September, and remain till April, except a few stray birds in a *state of change* that remain through the *monsoon.*

The *florikin* frequents long grass in preference to any other situation. It is sometimes met with in the grain-fields, also in fields of cotton and

dholl, and in the Carnatic so much in those of the grain called *wanagon*, as to be named the " *Wanagon Bird*."

It feeds chiefly in the morning, and is then easily raised, but during the heat of the day it lies very close, and is flushed with difficulty. It seldom flies far, but often runs a long way to escape being raised, especially on open ground. The chief food of the *florikin* is grasshoppers. I have also found blister beetles (*Mylabris*), scarabæi and other insects, and even occasionally centipedes and small lizards. I have sometimes, though rarely, heard it utter a kind of sharp *quirk* as it rose from the ground. It has also a kind of feeble plaintive chirp, or piping note when running. Its flesh is delicate, and of excellent flavour, and it is the most esteemed of the Indian game birds; and its pursuit is a favourite sport. From the open nature of the ground it frequents, it is well adapted for being hawked, and both the *Luggur* and *Shaheen* are often flown at it.

The egg is of a stunted thick ovoid form, very obtuse at the larger end, and of a dark olive colour.

Length of the male 18-19 inches; of wing 8; tail 4; tarsus hardly 4; bill front $1\frac{3}{10}$ths; weight 16-18 oz.

Length of female $19\frac{1}{2}$ to 21 inches; of one $20\frac{1}{2}$; wing $9\frac{3}{4}$; tail nearly 5; tarsus $4\frac{1}{2}$; bill front $1\frac{1}{2}$; weight 20 to 24 oz.; bill dusky above, edges of upper, and all lower mandible, whitish. Irides pale yellowish; legs dirty whitish yellow.

Family COLUMBIDÆ.—*Pigeons and Doves.*

Genus PTILINOPUS, Swains.

283.—*P. Elphinstonii*, Sykes.—*Imperial Pigeon* of the Neilgherries.

I have hitherto only found this fine pigeon in the dense woods on the summit of the Neilgherries, in small parties, or single. It is a retired and wary bird. I found various fruits and small shells in its stomach. Irides ochre yellow. Length about 15 inches.

Genus CARPOPHAGA, Selby.

284.—*C. œnea.*—*Col. œnea*, Auct.—*Pogonnah*, Mal.—*Imperial Green Pigeon.*

The *imperial pigeon* of Europeans on the West Coast is found in all the lofty forests of the West Coast, single or in small parties of 3 or 4. It feeds on various kinds of fruit, and has a single low plaintive note.

Irides and orbits, lake red; bill slaty, at base above red, at tip bluish white; legs lake red. Length 16 to 18 inches. I have never seen this bird with the knob on its bill as represented in books, nor have I heard of its ever being present.

285.—*C. cuprea.*—New species ?.—*Copper winged Imperial Pigeon.*

I possess a single specimen of a fine pigeon shot in the Wynaad by Captain Pope, of the Bombay army, to which, if it be a new species, the above name may be applied. It might be considered as the young of the last, but its large size, and the testimony of other sportsmen of a *copper winged pigeon* found in Coorg, lead me to suppose it distinct. I add a brief description. Head, neck, and beneath pale lilac grey or dun colour; chin white; back and wings brownish, with a faint coppery gloss; rump dark glossy cinereous; quills and tail dusky black, the latter tipped with cinereous; under tail coverts, yellowish white. Irides, orbits and feet red; bill red at base, cinereous at tip. Length 18 inches; wing $9\frac{1}{4}$; tail $6\frac{3}{4}$.

Genus VINAGO, Cuvier.—*Green Pigeons.*

286.—*V. militaris ?.*—*Hurriala*, vulgo *Hurwa*, H.—*Common Green Pigeon.*

This, the largest of its genus found in the peninsula, is at the same time by far the most common and universally spread, frequenting not only jungles, but groves, gardens, and especially the fine avenues of old banian, and other trees that line many of the roads in the southern part of the peninsula. It associates in large flocks, feeding much on the fig of the banian, and various other fruit trees. When seated quietly they are very difficult to distinguish among the green leaves.

Many are often brought down at a single discharge even when only 1 or 2 were visible. The *green pigeon* has a high flavour, and is considered excellent eating. As there is some doubt about the descriptions of this bird, which is represented as having *red* legs, and as Gould has figured as one of the sexes of this, a totally distinct species not found in the peninsula, I here add a brief description.

Head and neck, blue grey; back of neck, yellowish olive, bordered by a narrow band of blue grey; chin and throat grey, tinged with green; back and wings olive green; shoulders bluish purple; breast and abdomen yellowish green, mixed with bright yellow towards the lower abdomen and vent; under tail coverts reddish cinnamon colour, edged with yellowish

white; feathers of tarsus bright yellow; thigh coverts green, edged with whitish; tail entirely gray above; beneath blackish, with a broad margin of bluish white; feet saffron yellow; irides fine smalt blue, with an exterior circle of carmine; bill thick and strong, greenish white at base, bluish at the tip. Length 12 inches; wing 7½; tail 4.

In the young birds the under tail coverts are dusky green, edged with whitish, and this is the only material difference I have observed among numerous specimens from all parts of the country.

287.—*V. aromatica*, Auct.—*Marroon-backed green pigeon.*

I have only found this handsome green pigeon in small parties, in thick forest jungle in Malabar, and at the foot of the Neilgherries. One specimen differs somewhat from the others in having the face, forehead and chin yellow, the under tail coverts mottled with green and white, and in the bluish white tip of the lateral tail feathers being broader. This, I think, may be a young bird.

Bill and irides as in last: the former much more slender; feet and legs lake red. Length about 10½ inches; wing nearly 6; tail 4.

288.—*V. affinis.*—New species?—Young of last?

Descr.—Forehead and head grey; rest of plumage green; yellowish on chin; tail with centre feather green; exterior cinerous, with a black band near tip; under tail coverts barred with white and green; bill, irides, and feet as in the last; bill stronger. Length about 10½; tail 3½. This may be considered as the young of the last, which it resembles in size and form, but the absence of the rich marroon colour of back and wings, the fact of its being always found separate, and other circumstances, have induced me for the present to consider it as distinct. I have seen specimens of this pigeon in several collections made on the West Coast, but have only obtained it twice myself in forest jungle, and both times solitary.

289.—*V. bicincta.*—New species?—*V. purpurea*, Auct., Brown Ill. Zool.?—*V. vernans*, var., Less. Traité.—*Purple* and *orange breasted green pigeon.*

Descr.—Back of head and neck above blue grey; forehead, top of head, face, chin, throat, belly and rest of the plumage above, green of different shades; a broad band of orange or bright cinnamon yellow, on the breast, separated from the green of the throat by a light purple band; lower belly and vent yellow; some of the feathers streaked with green; under tail coverts entirely cinnamon colour: tail above grey, with a central dark band, and edged lighter; beneath almost black; whitish at the tip; edges of the

wing cover ts marked with yellow more broadly than in the other of this genus. Length about 10 inches ; wing 6 ; tail rather more than 4 ; feet red ; bill and irides as in others of the genus.

I have only seen this very prettily plumaged *green pigeon* in a tract of jungle near the sea coast, south of Tellicherry.

289, bis. V. *unicolor.*—New species ?—Young of last ?

Descr.—Above entirely olive green, except a shade of blue grey on the back of the neck ; beneath and forehead yellow green, almost yellow at the vent ; under tail coverts white, mixed with yellow and cinnamon ; tail and wings as in the last. Length the same ; wings and tail rather shorter.

I shot a single specimen of this pigeon in a grove of trees at Bimlipatam, in the Northern Circars, and have never again seen it. It is of the same slender make as the last species, and may be a young bird, but its very different locality has led me to place it separately for the present.

Gen. COLUMBA.

290.—*C. œnas*, L.—*Kabootur*, H.—*Blue pigeons.*

The blue pigeon abounds over all India, occasionally found in the more open spaces of jungles, especially in rocky districts, and in the neighbourhood of waterfalls—but more generally in the open country, inhabiting walls of villages, pagodas, wells, and any large buildings, and breeding chiefly in old walls.

Irides orange ; legs red.

291.—*C. Javanica.*—*Bronze-winged Dove.*—*Imperial Dove* of some.

This very lovely pigeon somewhat approaches the turtles in form, and may be considered as a link joining them to the pigeons, from which it differs in having rather longer tarsi, and in the outer toe being slightly shorter than the inner.

It is a denizen of the thickest jungles, coming to the more open spaces to feed. I have seen it in Goomsoor, in Malabar and the Wynaad, and near the top of the Neilgherries, on the Coonoor pass. It feeds chiefly on the ground on various seeds, is solitary, a shy and wary bird, and of very rapid flight. Irides orange. Length nearly 12 inches.

Gen. TURTUR, Selby.—*Fachtah*, H.—*Doves.*

292.—*T. tigrinus.*—*Col. tigrina*, Temm.—*Chitroka Fachtah*, H.

This handsome dove is most abundant in the neighbourhood of, and

among thick and lofty jungles. It is, however, also met with in groves of trees in the neighbourhood of the more wooded villages and towns, both in the Carnatic and Deccan.

Irides lake red; length about 12 inches, of which tail is 5. I have seen a nearly albino variety of this bird once or twice, being of a pinkish white colour throughout.

293.—*T. Cambayensis.*—*Col. Cambayensis*, Lath.—*Tortroo Fachtah*, H.

This little dove abounds over most of India, both in low jungles and near villages and cantonments, being found especially towards the north in every garden, and frequenting stable yards, houses, &c.

Irides dark brown.

294.—*T. risoria.*—*Col. risoria*, L.—*Dhor Fachtah*, H.

This large dove is found over all the country, frequenting hedges and trees in the neighbourhood of cultivation, also low bushy jungle.

Irides fine ruby red.

295.—*T. humilis.*—*Col. humilis*, Temm.—*Serotee Fachtah*, H.

Found, though more rarely than any of the last, over all India, frequenting groves of trees, hedge rows, &c. in the neighbourhood of cultivation.

Irides dark brown.

None of these four doves are gregarious, being generally found in pairs, though at certain seasons they occasionally congregate in flocks of various size.

296.—*T. meena.*—*Col. meena*, Sykes.—*Col. Turtur*, var. ?—*Kullur Fachtah*, H.

I have hitherto only found this species of dove in the jungles of Goomsoor, where it is tolerably abundant, associating in flocks of various size. It is enumerated by Mr. Elliot as found in the Southern Mahratta Country, but I did not observe it in the forests of Malabar.

Irides orange. Length 13 inches.

(To be continued.)

II.—*List of Minerals for presentation to the Society, collected from various parts of the Nizam's territories, Ceded Districts, Kurnool, the Southern Mahratta Country, Mysore, &c.—By Lieut.* T. J. Newbold, *23d Light Infantry.*

No. 1.—A. Gneiss of Dummul at the base of the Kupputgode hills, Southern Mahratta Country, the weathered transition gneiss of Christie.

No 1.—B. Not weathered variety, same locality, with pale rose-coloured felspar.

2.—Mica schist, compact variety, Kupputgode hills. Before the blow-pipe, *per se*, in the platinum forceps, this rock fuses into a black enamel.

3.—Yellowish brown jaspery chert, same locality as the above, used by Hyder and Tippoo for gun-flints; fracture conchoidal, translucent at edges.

4.—Basanite, or flinty slate traversed by quartz veins, associated with the schists of the Kupputgode range.

5.—Lateretoidal rock, into which the higher and more ferruginous portions of the schists, composing the Kupputgode hills, pass.

6.—Black oxide of manganese, combined with oxide of iron and alumina; with decomposing quartz and felspar veins: thee xterior exhibiting a disposition to the botryoidal structure.

7.—Variety of the above.

8.—Do. do.

9.—Porphyritic chlorite rock. Pale rose-coloured crystals of felspar imbedded in a siliceous paste, coloured by chlorite; some of the crystals decomposing into a whitish clay. This rock is associated with the siliceous chlorite schist of the Kupputgode hills. Although, petrographically considered, it might be correctly pronounced a porphyry, yet I have preferred the name just given it, as more in keeping with the geognostic position of the rock. This rock I have seen in various parts of Mysore and the Ceded Districts, associated with granite and the primary schists.

10.—A. Chlorite slate, same locality.

10.—B. Do. siliceous variety, exhibiting the tendency of this rock to split into rhomboids.

11.—Siliceous mica slate, same locality, showing traces of copper.

12.—White sub-crystalline limestone—the more granular varieties closely resemble Carara marble—in veins in the schistous diorite, Kupputgode range.

13th.—Do. do. altered in colour, near line of contact with the slate.

14th.—Rhomboidal calc-spar, same locality.

15th.—Singular calcareous rock; composed of minute angular fragments of a dark glistening quartz, and crystals of pale flesh-coloured felspar, cemented together by a greenish, granular, sub-crystalline paste, composed chiefly of carbonate of lime. It occurs in a hill near the village of Hurti, on the southern flank of the Kupputgode range, not far from the Putwurden's territory. The hill has a mammiform shape, having its surface covered with detached angular and rugged masses of this rock, which appear to have been subjected to the action of violent disruptive force. It is very likely to be mistaken, from the colour, hardness and granular texture, for a variety of massive siliceous chlorite rock, and in some specimens resembles diallage and serpentine; but on the application of a lens, and indeed by the naked eye, on closer inspection, its true aggregate character may be distinctly recognized. The application of dilute nitric acid to the rock in substance excites but a feeble effervescence; but on the powder the extrication of carbonic acid gas is abundantly evident. It often imbeds cubic pyrites of iron. The felspar, the dark quartz crystals, and dull green hue of the rock, possibly indicate its origin from the chloritic slates of the Kupputgode hills.

16.—Variety of the foregoing, less crystalline in texture, imbedding cubic brass and liver-coloured pyrites. Colour, dull green, with reddish brown delineations, assimilating some varieties of serpentine. From the minute glittering scales of mica, observable in this rock, and its softer texture, it would appear to have been formed out of the debris of the neighbouring mica slate. It effervesces with the dilute mineral acids: before the blow pipe, *per se*, it phosphoresces slightly, and exhibits on its edges shining points of black enamel. The compact varieties of this rock are susceptible of a high polish, and are used as an ornamental building stone. Some of the exquisitely polished slabs in the elaborately sculptured little mosque in the town of Lachmaisir, in the territory of the Mahratta Chintaman Row Putwurden, are of this stone, retaining the pyrites which shine like so many spots of gold on its polished surface. The chlorite slate too of this part of the Southern Mahratta Country imbeds pyrites.

17.—Variety of the above, with cubic liver and gold-coloured pyrites, projecting from the weather-worn surface None of these rocks have been noticed either by Christie or Colonel Sykes.

18.—Clay slate of Darwar, red and white, noticed by Christie, composed principally of decomposed felspar, more or less coloured with iron, and having a loose aggregation. Chlorite also occurs; and to the presence of this mineral may be attributed the peculiar shining flaky structure, and the greenish tinge of many of the surrounding slates.

The specimen is from a bed of slate that has suffered considerable flexure from the intrusion of a dyke of basaltic greenstone, and from its softness assimilates the character of a shell or slate clay. Before the blow-pipe the whiter portions melt, *per se*, into a white enamel; the red parts blacken at first, and fuse with some difficulty into a shining black slag, more or less affected by the magnet.

19.—Dark blue roofing slate of Kulladghee, occurs both laminar and massive, it is easily cut by the Wudras on the spot into excellent writing or roofing slates. Some varieties are so massive that pillars, many feet in height, are quarried from it, and some so finely lamellar that leaves, two or three feet square, almost as thin as pasteboard, may be separated. A capital writing slate and pencil were cut for me out of the quarries, and shaped and polished, all in a couple of hours. This formation furnishes good hones ; specimens of which I have already furnished.

20.—Variegated clay slate, penetrated by calcarious infiltration, associated with transition limestone of Kulladghee.

21.—Chlorite slate, of Kittoor.

22.—Talc slate from the Falls of Gairsipa, Western Ghauts, reddish grey ; less weathered portions, greenish grey ; streak nearly white, sectile, greasy feel, structure laminar tables, glimmering lustre, translucent at edge, easily frangible. Almost infusible before the blow-pipe, the plates separate and whiten.

23.—Actynolitic schist, associated with the talc, mica and hornblende schists at the Falls of Gairsipa. Minute acicular crystals of actynolite, without any common direction, distributed irregularly throughout the structure of this rock, impart a glimmering appearance ; a few scales of mica are disseminated: colour grass green, feel harsh, easily frangible, fracture granular, inclining to slaty, streak greenish grey. Before the blow-pipe, *per se*, it first whitens and finally fuses into a green enamel.

24.—Hornblende schist or schistous diorite, Falls of Gairsipa, identical with the rock described by Christie, as consisting almost entirely of hornblende.

25.—Mica schist, Falls of Gairsipa.

26.—Do. do. imbedding decaying garnets in dodecahedrons.

27.—Mica schist passing into gneiss—same locality as the above.

28.—This is the rock described by Christie, as being a variety of granite, which differs from the common granite of India, and as not being so old ; composed of small grains of white felspar, quartz, and mica ; has, in some instances a slaty appearance, and is associated with gneiss and hornblende schist.

From a careful examination of this rock and its associated schists, *in*

situ, and from its decidedly stratified character, I should rather be inclined to pronounce it thick bedded or granitoidal gneiss ; in some hand specimens, however, it is not to be distinguished from true granite. It is an interesting specimen to the advocates daily gaining ground, of the theory of the mineral metamorphism of rocks, constituting one of the almost imperceptible gradations by which a normal rock is supposed by Keilhan and others to pass into rocks, generally considered abnormal, or in other words involving doubts as to the plutonic origin of granite. Gairsipa, not only affords to the geologist an instructive and beautiful exposé of the rocks of the gneiss and mica schist system, the dip and direction of strata, but affords to the lover of nature, the magnificent spectacle of one of the most stupendous (in point of height) cataracts on the face of the globe, tumbling over a precipice of these rocks more than eight times the height of the celebrated Falls of Niagara. The breadth of the river above the Falls is about 300 yards ; it was full from bank to bank at the time of my visit : the depth of the stream on the average about 10 feet. The sheer height of the scarp over which the waters were precipitated, according to careful measurements, twice repeated, communicated to me by Mr. T. Lushington, 888 feet to the surface of the water in the basin, and the depth of the basin 300 feet, making a total of 1188 feet. The height of Niagara is about 140 feet, but the breadth of the river far exceeds that of Gairsipa.

29.—Gneiss of Gairsipa, hornblende replacing mica, which appears in scales, disseminated among the former mineral.

30.—Variety do. do.—same locality.

31.—Gneiss passing into hornblende schist—same locality.

32.—Talcose pot-stone (*lapis ollaris*), associated with the talc slate in the S. E. part of the Darwar district. Christie observes, that all "the fine plaster with which the walls of the houses are covered in India, and which is so much admired by strangers, is composed of a mixture of fine lime and soapstone, rubbed down with water : when the plaster is nearly dry, it is rubbed over with a dry piece of soapstone which gives it a polish very much resembling that of polished marble." This stone I have also found associated with asbestus in the talcose slate of the western parts of Mysore : it is cut into pencils and used by the natives for writing on cloth, stiffened and prepared with charcoal, and is held in holy estimation both by the Brahmins, the Jangams and laity of the Lingayet sect. By the former it is hollowed out into vessels used in preparing their food, and by the latter for their phallitic emblem, which is preserved inviolate from unhallowed gaze in the small silver box, which the worshippers of the *lingum* invariably carry about their per-

ons for the purposes of adoration. Some varieties are used in parts of the Ceded Districts and Mysore to grind the sandal wood into powder, for the composition of the *ticá*, with which some castes of the natives mark their foreheads. An argillaceous variety procured between Tarputtri and Cuddapah is carved, like the agalmatolite of China, into images representing the whole Hindu pantheon, avatars of Vishnu, &c. The darker and more compact varieties often assimilate serpentine, and take a fine polish. This stone is in great request for the larger kind of idols that usually sit or stand enshrined in the *Vimanas* of Hindu temples, and many of the ancient inscriptions of the Southern Mahratta Country, Mysore, the Nizam's territories, are engraven on pillars or blocks of this mineral. Some of the beautifully polished pillars, and inscribed slabs in the ruined temples of the old Hindu capital of Bijanugger and Annagundi are of this stone. In Mysore, whole temples are constructed of it. The dark coloured stone, of which the pillars supporting the elegant mausoleum of Hyder and Tippoo, near the Lal Bagh at Seringapatam, are composed, appears to me, after a close examination of the pillars themselves and the quarries at Turivicary, whence the stone was brought, to be a highly indurated ferruginous, and crystalline variety of this rock, having some of the characters of a serpentine, rather than the basaltic or hornblende rock, which Buchanan and Benza have severally pronounced it to be. Specimens of this variety taken from the quarries of Turivicary, and also of the potstone of Mysore, I have forwarded for presentation.

33.—Marble from Kulladghee, pale flesh-coloured, occurs in beds and veins in the surrounding slates and limestone, assimilating in texture, colour and fineness of polish the Tiree marble, but does not imbed mica, hornblende, or sahlite: chlorite, however, is sometimes seen in their greenish seams. Specimens of the lithographic limestones near Kulladghee and Bagalcota, have been already transmitted to the Society.

34.—White marble from Bagalcota, streaked with green chloritic zones resembling the antique Cipolin marble.

35.—Lithographic limestone from Kurnool, imbedding stalactiform oxide of iron.

36.—White marble from Kulladghee.

37.—Drab-coloured limestone from Talicota, in the Rastea's territory, laminar and compact, exhibiting delicate arborescencies between the laminæ, or layers of deposition.

38.—Crystalline limestone, approaching marble in texture, from Kurnool. Colour mottled green and white; translucent in thin fragments, difficultly frangible, some varieties are so hard as to give fire with steel,

fracture granular crystalline. This stone is susceptible of a fine polish, and might be employed with advantage in ornamental slabs for inscriptions, vases, &c. It occurs near the line of contact with the schistous chlorite, from which it probably derives its peculiar hardness and colour.

39. Lim estone of Kurnool altered by contact with the schistous chlorite; colour, dull green, streaked with dark purplish ferruginous bands; fracture granular, sub-crystalline, extremely tough under the hammer, effervesces feebly with dilute mineral acids. Some varieties imbed pyrites and assimilate serpentine. It occurs at Kurnool, and on the tongue of land between the confluence of the Tumbuddra and Kistnah rivers.

40th.—Quartz rock of Darwar, coloured with iron, and containing nests of decayed quartz and felspar, passing into kaolin, and often tinted yellow, brown, and reddish by oxide of iron. In the hilly zone extending between Kittoor and Darwar, there is a variety that exactly resembles the rock composing the upper portions of the copper mountain and Sondur ranges, being of a jaspery and highly ferruginous clay, sometimes passing into a true ore of iron, with a cherty quartz in alternate layers, generally on their edges, and varying from the eighth part of an inch, to an inch in thickness. The laminæ are frequently contorted and bent, and impart a curious waved or striped appearance to the rock. It occupies a similar geognostic position, and is seen generally cresting the slaty hills around Kittoor. Sometimes, as Christie accurately observes, the base of the rock is white or grey, and traversed in all directions by dark brown-coloured veins, highly impregnated with iron: but in some specimens, the dark brown variety is in much larger quantity than the white basis; and then the latter appears as if it had been broken into a number of small angular fragments, which had afterwards been united by the consolidation of the brown variety from the fluid form. This variety contains numerous small cavities which are lined with red hæmatite in the shape of stalactites, or having a blistered, or mammillary form. The cavities are generally very small. This rock in petrographical structure and geognostic position, we may safely pronounce to be identical with that composing the precipitous sides of the Bimagundi pass into the Sondur valley (described at page 147 Journal No. 20); and associated with it, we find, near Kittoor, as at Sondur, a magnetic iron ore with polarity, exhibiting a similar laminar structure and a like tendency to split into rhomboidal paralellograms.

41.—Breccia, of the old red sandstone formation of Christie, from the north bank of the Malpurba, Southern Mahratta Country; a reddish brown

quartzy paste imbedding angular fragments of white and reddish quartz, with felspar disseminated.

42.—Do. do. a ferruginous paste, cementing fragments of a decomposing chert, apparently from veins in the associated limestone; the paste approaches a true iron ore, and contains small cavities lined with a mammillary hæmatite.

43.—Pudding-stone from the old red sandstone formation, north of the Malpurba :—rounded pebbles of quartz rock imbedded in a crystalline reddish brown sandstone.

44.—Diaphonous quartz with a bluish tint, mentioned by Christie, associated with the sandstone; from the hill south of Kulladghee and near Padshapoor. I have forwarded specimens of the white variegated sand stones of Badami and Mudibhal.

45.—Alum in whitish earthy superficial efflorescences between the laminæ and on the air-exposed surfaces of a purplish aluminiferous shale, alternating with the old red sandstone, in the cliffs at the falls of the Gutpurba near Gokauk. The occurrence of this mineral in the formations of the Southern Mahratta Country appears to have escaped the observations of Marshall, Christie and Sykes. It is found in the lower portions of the cliffs, constituting the precipice over which the Gutpurba rolls on its passage to the low country, through which the Kistnah flows, at the bottom of one of those singular and deep fissures that clear the sandstone rocks from summit to base. The shale in which it occurs is a common slate clay, of a purplish brown hue, and tastes, generally, distinctly of alum, which, however, rarely appears in an efflorescent state, save on air-exposed surfaces : it does not resemble in the slightest degree the globular greyish black alum slate of Europe, nor its bituminous aluminiferous shale. I have also discovered alum and common salt in the rocks of the copper mountain range in a similar efflorescent state, in a rock, resembling somewhat the glassy alum slate of mineralogists, but cellular, ferruginous, and exhibiting purple and yellow iridescent hues. Captain Arthur informed Sir Whitelaw Ainslie that he discovered alum in Travancore, in a soft dark coloured laminated earthy matter, which contained sulphur in the state of sulphuret of iron; and that at certain depths in the soil, under the laminated matter, he observed a regular stratum of charcoal, a circumstance which led him to conjecture that the bed in which the mineral is found is of a vegetable origin; and we know that it has been ascertained by Vauquelin and others that in what is termed the alum ore of *La Tolfa*, potass is met with in considerable quantity. Alum is associated with the coal measures and bitumeniferous rocks of Europe, its existence therefore in the sandstone rocks of

the Southern Mahratta Country may be regarded with some interest, as indicative, if not of the existence of coal, at least of the age of the formation. Alum, we are told by Dr. Davy, exists in certain caves in the interior of Ceylon. Mr. Elphinstone states that it exists in the clay of Calabaugh in Cabul, and according to Captain Macdonald Kinneir it is found in the mountains south of Kelat, in the province of Mekran. It is also brought in considerable quantities from the mountains of Nepaul, where according to Mr. Campbell, it is said to exude from the surface of soft rocks, and sometimes to be dug out of their substance ; from these sources it is collected in considerable quantities, during the cold and dry seasons, and carried by the *Bhoteahs*, *Murmis*, and other hill people, to Katmandu, to be exchanged with the merchants of that city for money or other articles. Mr. Campbell also informs us that there is a dark bituminous substance, used in Nepaul, said to be exuded from rocks; which is called black alum or *salajit:* it resembles, in external character, the bituminous alum ore which is said to be found in Sweden, and in many coal mines in England, but there is much vegetable matter in it, although the Nepaul physicians believe it to be a mineral. Alum also exists in Behar, where it was discovered by Dr. Buchanan, and also in the Vindhya mountains, but the great bulk of this valuable mineral, which is used extensively by the natives of India in medicine and the arts, is imported from China.

46.—Secondary trap of Christie, from the vicinity of Belgaum—vesicular.

47.—Amygdaloid (same locality) imbedding zeolite and calc-spar. A more compact variety occurs imbedding nodules of calcedony. This rock escaped the observation of Christie, who states he never saw the amygdaloid in sitû.

48.—Lateritic conglomerate, capping slate and limestone of Kulladghee.

49.—Laterite of Beder—Nizam's territory.

50.—Variety do., exhibiting interior of tubular sinuous cavities, having a greyish green indurated enduit.

51.—Variety do. do. compact—Beder.

52.—Do. do. near the line of contact with flœtz trap—Beder.

53.—Do. do. with a somewhat cancellar structure—Beder.

54.—Indurated lithomarge bed, between laterite and trap—often calcareous—Beder.

55.—Variety of laterite with cavities filled with white lithomargic earth—Beder.

56.—Purple lithomarge in laterite of Beder.

57.—Flœtz trap, near the line of contact, where the laterite is seen superimposed—Beder.

58.—Basalt underlying laterite cliffs of Beder.

59.—Termination of black veins in the laterite of Beder, near its junction with the trap, in combination with iron and alumina.

59 A.—Black oxide of manganese in combination with iron, from veins in laterite of Beder.

60.—Lateritic conglomerate, capping laterite of Beder. It exactly resembles a similar rock, distinct from the true laterite, capping the laterite of the ghauts and Western Coast, composed of ferruginous nodules, cemented together by a felspathic paste of various shades of yellow, brown, and red, coloured by oxide of iron. This rock occasionally presents a shining glazed-like surface. In tracts where travertine and limestone prevail, as in the vicinity of Bijapore, and Baugwari, the lime often enters the cement of this conglomerate.

61.—Nodule in laterite of Beder, imbedding a mineral, with a green and purple iridescent hue, probably iron.

62.—Laterite of the western ghauts—Devamani pass, Upper Canara.

63.—Lateritic conglomerate, capping laterite of the western ghauts, summit of Hossdroog pass, Upper Canara.

64.—Laterite of the Western Coast, quartzy variety, from Onore. Specimens of this rock from theMalayan Peninsula, Cannanore, Mangalore, the Bisley and Heggalla Passes, the lateritic rocks capping the slate and sandstone ridges of the Ceded Districts, the neighbourhood of Bangalore and Nundidroog, &c. have already been transmitted.

65.—Variety of laterite from Onore—felspathic.

66.—Do. do. Western Coast, from Compta, north of Onore, exhibiting the externally black superficies, so often noticed in the weather exposed masses of this rock.

67.—Variety from base of western ghauts, near Meerjan.

68.—Do. do from the vicinity of Soonda, in Upper Canara.

69.—Do. do. from Banwassi, in Upper Canara, near the western boundary of Mysore.

70.—Lateritic conglomerate, capping the laterite cliffs which overlie the flœtz trap formation of the Deccan ; hills near the city of Gulberga—Nizam's territories

71.—Greenish white felspathic sandstone, of an earthy friable texture, with small angular fragments of quartz, associated with the overlying trap at Bangwari, near Belgaum. It sometimes imbeds dark ferruginous nodules in a state of disintegration.

72.—Travertine with dendritic appearances, between Hyderabad and Beder.

73.—Amygdaloid associated with the great overlying trap formation of the Deccan, containing globules of a species of zeolite, resembling apophyllite in its behaviour before the blow-pipe—frosted pearly exterior, and peculiar splendent planes. It exfoliates, curls, and froths, before the blow-pipe, and finally melts into a white enamel. This amygdaloid also contains calc-spar, mesotype, and stilbite. It is from Ipperghi, near the boundary of the Solapoor Rajah's country.

74.—Stellated zeolite in rhomboidal calc-spar, Solapoor territory. This is an interesting specimen, showing the gradual pseudo-morphic changes of the two minerals. A white zone appears to define the limits of each, beyond this they become in a certain degree blended: the zeolitic rays may be seen decussating and diverging from their several centres, through the transparent substance of the calc-spar.

75.—Radiated zeolite—rolled fragments from the bed of the Bhima—Nizam's territories.

76.—Red jasper from the Kistnah—do.

77.—Yellow jasper from the Malpurba—Southern Mahratta Country.

78.—Mocha stone, enclosing nest of quartz, bed of the Bhima.

79.—Cornelian—bed of the Kistnah, at Paugtoor.

80.—Calcedony—botryoidal, from the vicinity of Ipperghi—Solapoor Rajah's territory.

81.—Oriental agate.—Numerous specimens of this beautiful mineral, some assimilating the onyx, sarde, and sardonyx, I have already forwarded to the Society, as also of glauconite, various kinds of zeolite, chrysoprase, heliotrope, &c., occurring in the flœtz trap formation of the Deccan.

82.—Agate imbedding quartz.

83.—Moss agate—bed of the Kistnah, at Paugtoor.

84.—Amethystine quartz crystal, from Golconda—Hyderabad.

85.—Do. do. from Cupputral, Ceded Districts, where the sandstone comes in contact with the granite.

86.—Pale buff coloured sparry limestone, associated with the overlying trap formation of the Deccan and the laterite. Locality, hills of Ingliswara, near Baugwari—Bijapore territory.

87.—Variety—reddish.

88.—Limestone, greyish white, imbedding broken fragments of bivalved shells, converted into chert, associated with the overlying trap formation near its southern limit, between Hyderabad and Beder.

89.—More compact variety—same formation near Firozeabad, Nizam's territory, imbedding both univalve and bi-valve shells.

90.—Do. do. same formation from the vicinity of Koolkondah, presented by my friend Lieut. Wyndham.

91.—Do. do. pale buff coloured, imbedding nummulites.

92.—Variety, whiter and more crystalline. Both the last named specimens were found on the river bank at Onore on the Western Coast, and, if credit may be attached to enquiries made on the spot, were brought thither by native trading craft from the coast to the northward as ballast. Fossiliferous limestone, we know, occurs in the Kattywar peninsula, and the island of Perim, but the natives assured me the nummulitic limestone at Onore, was brought from places considerably to the south of these places. It is possible, however, that the spot where they were picked up by the native boatmen is at some distance from their true situs, as all the fragments have a rolled and water-worn appearance, as if they had been washed by the tidal wave on a sea coast. A piece of coral rag with shells *(ostrea)* adherent, was also picked up among the fragments of limestone at Onore. It would be matter of some interest to ascertain from the boatmen themselves, the exact localities where they took in these stones as ballast. My visit to Onore was extremely brief, and during the monsoon, when no boats can approach the coast, and all trade by sea suspended. Nummulitic limestone occurs at Chirra Punji. Burnes observed nummulites in the limestones of the Chari range at Liseput, in Cutch. Mr. Colebrooke first brought this rock to notice in 1824. It was met with at the foot of the Kasya mountains. Shell limestone, I believe, was discovered in the Madras presidency by Colonel Cullen, at Paddapangallee, in the Northern Circars, underlying basalt, and in the Hyderabad territory, by Voysey, in 1819-20. Malcolmson and Benza have since added to these discoveries.

93.—Hexahedral pyramid of adamantine spar, bluish white, from the Corundum pits, in the west of Mysore near Gram. This mineral is almost confined to India and China, and has been long known in the former country under the term of *Korund*—hence its European name. It is used principally in India, Ceylon and Arabia, for polishing precious and other stones. The oriental ruby, sapphire, and topaz, are varieties. Corundum occurs in Ceylon, Mysore and Cuttack; it is rare in Europe, though a sub-species, emery, is found in abundance on the island of Naxos, near Smyrna and in Saxony.

94.—Green copper ore (malachite) from the copper mountain near Bellary. Before the blow-pipe, *per se*, it decrepitates, but finally fuses into a reddish brown mass, containing a bead of pure copper. Treated

with acids it affords from re-agents the usual indications of this metal.

95.—Iron glance, imbedded in white quartz, from the hills of Copputral, Ceded Districts, the *fer oligiste* of French mineralogists. Before the blow-pipe, *per se*, it blackens and becomes affected by the magnet. Iron glance yields an excellent malleable ore.

96.—Granular magnetic iron ore, from Mutpalle—Nizam's country.

97.—Red hematitic iron ore, from the iron clay near Kondassur—Nizam's country. The iron produced from the two last named varieties is used when blended to produce the celebrated wootz steel, which is exported to Persia and Arabia for sabre blades.

98.—Specular iron ore—Sondur hills, Ceded Districts. It, as well as the micacious iron ore, is often sold as *surmah*, or antimony, in the bazaars of Southern India, and applied in the state of a powder to eyelids of women and children.

99.—Lead ore (galena) near Jungumrazpilly, in the Nulla Mulla hills, north of Cuddapah, said to be combined with silver and antimony.

100.—Gold dust in magnetic iron sand with menaccanite, silver and copper ore (and platinum ?) in the bed of the Doni rivulet, Kupputgode hills, South Mahratta Country.

101.—Native silver—same locality.

102.—Grey silver ore—do.

103.—Green carbonate of copper—do.

104.—Native copper—do. do.

105.—Tin ore (oxide) from Malacca.

106.—Diamond alluvium; from the diamond pits at Ramulacota—Kurnool.

107.—Do. do. last washings.

108.—Cacholong, milk white, opaque, fracture semiconchoidal. This specimen presents both the hard and the soft earthy varieties, noticed by Brongniart in the cacholongs found by him at Champigny, the former exhibiting a shining fracture, while the latter is chalky, light, and adheres to the tongue.

109.—Brown indurated clay, imbedding quartz crystals, and covered with yellowish annular and lenticular delineations, assimilating organic remains, associated with laterite, resting on the flœtz trap of the Deccan, south of Bijapore.

*110.—Mineral from edge of trap dyke, near Tallapodatoor, Ceded Districts.

111.—Nodule of indurated clay from lateritic formation—Nellore.

* I regret leisure will not admit of my noting this mineral.

112.—Asbestiform tremolite, found in veins, with adularia and magnetic iron ore in mica slate—Adepuram, Nellore mining district. It occurs in minute diverging fibres, with silky lustre, often stained by oxide of iron, frangible, scratches glass with difficulty, phosphoresces slightly, and whitens before the blow-pipe.

113.—Adularia associated with the above; scratches glass, lustre splendent, rather vitreous on the perfect planes, and pearly on the broader lateral planes. Before the blow-pipe, *per se*, it whitens and fuses on thin edges into a transparent glass. It is about 6° hardness of Mohs.

114.—Do. imbedded in kunker—same locality as the above.

115.—Variety of iron ore, resembling externally the titaniferous iron ore of the Neilgherries; after exposure to a red heat it becomes magnetic. It occurs in compressed laminæ, in seams of a garnetic quartz bed in the mica schist at Kunchgarlconda—Nellore.

116.—Garnetic quartz bed in mica schist—Kunchgarlconda.

117.—Honey-combed quartz: most of the cavities are filled or lined with an orange brown powder, which, before the blow-pipe, blackens and becomes magnetic.

118.—Quartz with magnetic iron ore foliated, garnets and mica, and exhibiting traces of copper, Ademulepuram—Nellore.

119.—Do. do. with rhombic dodecahedral garnets, resembling essonite.

120.—Granular garnet rock—same locality. This rock from its apparent weight, hardness, colour and tendency to take a crystalline form, might easily be mistaken for granular corundum at first sight. It is finely granular in structure, and has the appearance of a purplish red jasper. It often occurs in nodules which assume a rudely dodecahedral form or prisms, with three sided summits. It occurs in beds in the hornblende and mica schists of the Nellore mining districts, near Gurumanypenta, associated with asbestiform tremolite and adularia. Like precious garnet, it fuses, *per se*, before the blow-pipe into bluish black enamel.

121.—Red mineral in shining plates, resembling felspar, between laminæ of mica schist, base of Udeghirry mountains—Nellore. Softer than felspar, streak reddish white. Before the blow-pipe, *per se*, fuses easily with intumescence and phosphorescence, and curling up into a white enamel; with phosphate of soda into a topaz coloured glass, which becomes colourless on cooling, and with borax into a faint greenish glass, which also loses its colour on cooling.

122.—Pale rose coloured quartz—same locality.

123.—Gravel, brought down by mountain torrents, containing rolled and angular fragments of iron ore, garnets, schists, and copper ore.

124.—Mica schist with garnets and carbonate of copper—Gurumanypenta, Nellore mining district.

125.—Carbonate of copper in layers in hornblende schist—Bungeral Mettah, Nellore mining district. Mr. Prinsep thinks the phenomenon of the ore alternating with the hornblende interesting in a geological point of view, as affording exactly the appearance of gradual deposition from a liquid, at this earliest period of geological formations. But when we see, as in some specimens of this very rock, the ore running through it in fissures and lines nearly perpendicular to those of stratification, we must look to some other cause than a mechanical deposition from a liquid to account for its occurrence in such situations, and pause ere we pronounce the ore to be coeval with the primary rock which imbeds it.

126.—Mica schist, in which the mica is, in part replaced by innumerable small garnets, imparting a granular structure to the rock.

127.— Specimens of the copper ore, principally from Gurumanypenta, Bungeral Mettah, Salighirry and Yerrapully—Nellore: they present for the most part the carbonate passing into malachite and mountain blue. Some fragments have a quartzose matrix; both coloured green, and appearing so, from the imbedded ores—another variety runs in veins through a dark red oxide of iron, which Prinsep considers, to be the same as that of Dr. Thomson's specimen. (These ores have been analyzed in England, by Dr. Thomson, and more lately in India, by Mr. Prinsep, vide Madras Journal, for April 1836, p. 154). The mixture of sulphuret of iron, according to Prinsep, and perhaps of copper, with the oxide, gives the whole a dark arenaceous character. The first ore yielded 30.2 per cent of metal, and the last 39.5.

128.—Copper ore with grey metallic lustre internally, and penetrated with green streaks: probably the combination of the carbonate and sulphuret, mentioned by Prinsep as the richest ore met with, and yielding 69 per cent. of pure copper; highly malleable; specific gravity, interme diate between the carbonate and sulphuret.

129.—Schorl crystallized in prisms with quartz, mica and traces of copper: much finer crystals of this variety of tourmaline may be obtained from the locality whence these were obtained, but I had not the means of detaching them from their bed, which occurs in the mica schist of Bungeral Mettah, Nellore mining district. This variety of schorl *differs* slightly from that of Europe. It melts into a greenish grey enamel, instead of a black slag—hardness between quartz and topaz. With borax it fuses into a transparent glass tinged green.

130. Dark brown calcareous rock, structure passing from earthy to that of a fine indurated clay, associated in thin overlying beds with the plumbiferous limestone of Yungumrazpilly. It imbeds whitish tubular bodies, lined with minute whitish crystals (organic exuviæ ?).

131.—Do. do. with quartz and decomposing iron pyrites.

132.—Nodule of iron ore (magnetic) from Kunchgarlconda, Nellore, granular metallic lustre ; colour brownish black, streak brown, opaque, fracture uneven, infusible before the blow-pipe, *per se*, with borax it melts into a green glass.

133.—Quartz rock—Udeghirry Droog.

134.—Asbestus, in masses of fibres, passing from a dull greenish grey to a yellowish white mottled colour, with a slight soapy feel. Tough under the hammer, and breaks into fibrous woodlike fragments, which are not flexible in an unseparated state. It is found in a bed at Putsa Marculpilly, near Rayel-cherroo, Ceded Districts, in limestone, associated with a white indurated magnesian clay or earth. Before the blow-pipe, it fuses into a greenish grey enamel, which by a continuance of the reducing flame is converted into a brown slag.

135.—Magnesian earth indurated, associated with the above—same locality.

136—Indurated earthy vein in mica slate—Bungeral Mettah, Nellore. Colour faint reddish, white with scales of mica disseminated, effervescences feebly with acids.

Actynolite, carbonate of magnesia, and kyanite, occur in the mica and hornblende schists of the Nellore mining district, also a magnetic iron sand which is smelted, and abundance of hematitic iron ore. The soil often presents a sterile waste from the saline effervescences of the mineral alkali ; muriate of soda, and saltpetre, often attending metalliferous development.

III.—*Remarks upon the Auriferous Deposits of India, considered with especial Reference to their Economical Value.—By* Frederick Burr, *Esq.*

My attention having some years ago been directed to the geological structure and mineral capabilities of India, one of the facts which then struck me with regard to the latter subject, was the very extensive oc-

currence of auriferous deposits in various parts of the Indian peninsula. The impression made upon my mind at the time with regard to the immense diffusion of this metal, has during my residence in this country been fully confirmed—it is an important, though almost unheeded fact, that gold is very generally distributed, though in sparing deposits, throughout extensive tracts in India, extending from the tenth to beyond the thirtieth degree of north latitude. There is every reason to believe, therefore, that this metal might be made a new source of revenue to the state, of wealth to the country, and a profitable object of occupation to its population, were sufficient skill and attention devoted to the subject. It is with this object in view, that the following remarks have been written.

From the comparative rarity of practical science, among those observers to whom we are chiefly indebted for our knowledge of Indian mineralogy, it is not, I fear, possible to obtain from the details they have furnished us, any very clear or definite knowledge of the *actual richness* of these gold tracts. They are generally described as being poor, and containing the precious metal in very small proportions, but the poverty of metallic ores thus expressed, is entirely a relative term, and liable to much ambiguity. What it would be desirable to know, is the actual quantity or *per centage* of the precious metal, which can be extracted from a given quantity of mineral matter; with this datum we might form a correct idea of the value of the mineral, though it would still be desirable to know the cost of production, and the means of washing or reduction employed, as after all much would depend on the greater or less perfection of these processes. Gold except in a few rare cases, is always found in very sparing quantities, compared with the mass of sand, veinstone, or other mineral substance which accompanies it; which is in fact the principal cause of the high relative value of this metal: yet many auriferous deposits are by good management made to yield a profit by the skilful mining Engineer, which to the uninstructed eye would appear either totally destitute of the precious metal, or so poor as to be absolutely worthless.

Without attempting to describe, or even to point out every locality in this country, where gold has been ascertained to exist, I shall commence by briefly enumerating such of those tracts as now occur to me, and will most readily confirm my views of the abundant distribution of the precious metal throughout a large portion of the Indian peninsula.

Taking first the Madras presidency, gold is well known to occur in Coimbatoor, in numerous localities on the western and southern de-

clivities of the Neilgherry mountains, and other parts of the Malabar Coast, where it is commonly found disseminated in small particles in the sands and beds of rivers, and may be estimated to spread over an extent of several hundred square miles, forming the principal gold tract of Southern India. In the high table land of Mysore, gold is known to exist in many places, as near Bangalore and Chinnapatam, and in the Wynaad district. In the Southern Mahratta Country, the existence of gold is well known, and the deposits of the Kupputgode range have been described in the "Madras Journal of Science," by an energetic labourer in the field of Indian geology—Lieutenant Newbold. In the Northern Circars, and the Rajah of Berar's territory, gold is described as existing in many of the rivers, especially in the Nagpore district, almost the centre of India. I have also been informed by W. H. G. Mason, Esq. that the natives obtain a little gold by washing, in the streams near Vizagapatam.

This very brief and imperfect review of auriferous localities within the Madras territories, would be amply sufficient for our present purpose; yet it is deserving of notice, that these deposits of the precious metal, are equally abundant in the northern portion of the Indian peninsula as in the southern, as I shall now proceed to show.

Gold is known to exist in the tributaries of the Indus, in Kumaon, where it is obtained by washing in the streams in the vicinity of Kalsee. That these auriferous particles are derived either from the rocky escarpment of the Himalayahs, or the mountains subordinate to them, is highly probable, as gold mines are described as being worked by the Chinese Tartars north of these mountains near Hurtoh, beyond the lake Mansuraor. These gold workings are said to have been stopped by order of the Chinese government, lest the precious metal should be the means of tempting us across the snow clad pinnacles which bound the British territory. Gold is stated to occur in great abundance in Assam, where it is profitably worked by the natives at Gowhetti, on the Bramahputra. From this point deposits of gold are well known to extend southward through the Burmese empire, the Malayan peninsula, and the adjoining islands, but these localities it would be foreign to my present purpose to notice.

Of the actual economical value of this prodigious range of auriferous deposits, which has been shown to extend so widely over the Indian peninsula, little or nothing is, I believe, known. There is, however, the simple fact before us that in many places they have been worked by the natives, who must therefore have been able at least to obtain a subsistence from their labours, although carried on, we know, in the rudest

and most simple manner. When however, I consider the extreme poverty of the auriferous deposits, which by skilful and scientific management are profitably worked in Europe, and further take into account the very low price of labour in this country, I am firmly impressed with the conviction, looking at the subject in a practical point of view, that the application of the same means might in this country be made to produce an equally beneficial result. Although there is no reason to believe that our gold-washings generally, are rich enough to attract or to recompense individual enterprise, it is highly probable that in such a vast extent of country there may be some much richer than others. It is also probable, if not indeed certain, that there are many which might be made the means of affording a beneficial occupation to a large number of labourers, of contributing to the revenue of the state, and of forming in their aggregate results, a valuable addition to the metallic circulation of the country.

Should the experiment in question succeed, the benefits derivable from it, might, as I have shown, be very great; it would induce a more careful examination of numerous and widely spread auriferous deposits, a far more economical treatment of their produce, and very possibly the discovery of veins, or of limited tracts much richer than any hitherto made known by the casual discoveries of the natives. Even should the experiment fail, which is very unlikely, the expense might be limited from the first to a very moderate amount, while other indirect advantages, arising from an increased attention to the mineral capabilities of the country, might be confidently reckoned upon.

Supposing the auriferous deposits of India to attract the attention of Government, the plan which I should propose to follow, would be to obtain the services of some competent person, practically acquainted with the treatment of auriferous sands in Brazil, or with the reduction of gold ores, as practised in the Austrian mines. Perhaps a mining Engineer might be found, uniting both these qualifications. A careful examination of some of our auriferous sands, say those on the Malabar Coast, which evidently extend over several hundred square miles, would soon show where were the richest spots, and where the reduction works might be established with the greatest probability of success. The requisite apparatus need by no means be costly: it should embrace, besides minor articles commonly used in the washing and separation of gold, the amalgamation machinery, employed so successfully in the reduction of the poor quartzose ores of the Tyrol, and one or more furnaces to attempt the fusion of the auriferous sands, according to the plan successfully introduced in Russia about three years ago in the gold

works of the Ural mountains. The sands or other ores of gold might be bought of the natives, at a fixed valuation, according to the per centage of the precious metal which they were ultimately found to contain, a certain amount being paid to the contractors previous to their delivery. Were this species of industry to become thoroughly established in certain districts, as after a time it no doubt would do, the gold dust might form a useful medium of exchange, and be received by Government as "kist," which alone would give a powerful stimulus to production. Whether it would be most desirable for the mining Engineer appointed to the charge of the reduction works, to receive the auriferous sands from the gold washers in its first crude state, as originally collected by them, or whether it should first undergo some preliminary washing and concentration, is a consideration of some importance which could only be determined by experience.

In concluding this notice, I shall briefly draw attention to a subject which is too technical to be generally understood, although interesting in itself, and of primary importance as connected with the preceding suggestions. I allude to the actual produce, or *per centage* of gold, which can be profitably extracted from the ores or sands containing this metal, by the most economical and improved methods now practised in the gold mine districts of Europe and Brazil. From the data I shall now adduce it could easily be ascertained by a little chemical and mineralogical research, how far the auriferous deposits of India are likely to repay the improved system of realizing their produce, which I have now suggested. In fact from the very low price of labour in this country, there can be no doubt that ores of the same produce might be made to yield a much larger profit than in Europe, for in the *price* or *value* of the metals (gold and silver equally with any others), the actual labour expended in their production, forms by far the most considerable item.

It may be laid down as a general truth in mining, that, with very rare exceptions indeed, the ores of the precious metals are exceedingly poor, and that the metallic particles to be collected, bear but a very trivial proportion to the mass of worthless matter, throughout which nature has disseminated them. Thus in the silver mines both of Europe and America, the average produce of the bulk of ores extracted, does not exceed more than from 3 to 4 or 5 ounces in 100 pounds weight, or one pound of metal in 400 pounds of the ore. Yet silver ores of this low produce are in numerous instances profitably extracted from deep mines, where they have to be raised even three, four, or five hundred

yards to the surface, where powder is required for blasting the rock, water wheels, steam engines, or other expensive machinery for draining off the water, and where the price of labour is six, eight, or even ten times as great as it is in India. It is true that in these mines richer ores are also found, but they are in comparatively small proportion, fluctuating in their quantity and quality, and not to be depended on for profitable returns.

The value of gold being fifteen times greater than that of silver, it will readily be conceived that very minute quantities of this precious metal will pay for the expenses of extraction. In point of fact the poverty of some auriferous deposits is almost inconceivable, indeed it often happens that the particles of the precious metal are so very minute, and so sparingly scattered through the mass, that the naked eye is totally unable to detect them, and except by the careful mineralogist, the whole would be looked upon as mere worthless matter, and entirely rejected. Of this general poverty of gold ores, I shall now adduce a few striking examples, taken it will be observed from widely distant localities.

At Zelle in the Tyrol, a mineral district, situated a few leagues from Inspruck, the gold ores, or rather the auriferous mass extracted from the mines, yields on an average from five to seven ounces of the precious metal in 1,000 cwts. Now this amounts to only one pound of gold, in from two to three hundred thousand pounds of refuse, yet even from this exceedingly poor ore, the skill of the German mining Engineers, enables them to extract a small profit. The ore, I may further observe, is a hard quartz, very similar to that which occurs north of the Pennar River, in the Nellore district, and requires to be stamped or finely pulverized, before the gold can be extracted. At the mines of Kremnitz in Hungary, the average produce of the gold ores is only 7 to 8 ounces in the 1000 cwts, or 100,000 lbs, being thus very little higher than in the mines of Zelle.

Let us now turn to Brazil, a country well known for the large supply of gold which its mines annually furnish. The precious metal is here found in veins and worked by mining, but a vast quantity is also disseminated in very minute particles through the sands of certain auriferous districts, exactly as we have it in India. I have been informed by my friend Mr. Attwood, who has been resident for some years in the mineral districts of that country, that a cubic foot of this sand, which may be estimated as weighing about 1 cwt. is considered very profitable if it yields an *oitava*, or about one eighth of an ounce of gold, but that sands are worked which do not afford more than one-tenth of this produce.

In Carolina, in the United States, ores containing more than 1½ ounce per ton, or 1 lb of gold in 23,000 lbs of ore, may for the most part be worked with profit, although disseminated in a hard matrix of quartz which requires to be pulverized by machinery. It is also particularly deserving of remark, that the price of labour in Carolina, like most other parts of the United States, is very high, being a dollar, or two rupees per day.

From a consideration of all the facts which have now been detailed, it appears to me that we may safely arrive at the following conclusions :—

1st.—That there are in India, immense and almost unexplored tracts of auriferous country.

2nd.—That these have here and there been worked by the natives, though doubtless in the most rude and imperfect manner.

3d.—That the reputed poverty of many, may be after all merely relative, when compared with other districts, which by better means are made to yield a profitable return.

4th.—That taking into account the occurrence of the precious metal in India, at the surface of the ground, and the very low price of labour in this country, compared with Europe or America, there is in all probability an ample field for increasing the revenue and benefitting the population, by the extensive introduction of gold washing and amalgamation, upon the same improved and economical system as is practised in the above quarters of the globe.

I shall mention in conclusion, that, by means very similar to what I have now suggested, Russia has within the last few years laid open a new and important source of wealth to the empire. At the commencement of the present century, in fact till within the last few years, the mineral district of the Ural mountains was almost unknown, and only productive to a small extent. Careful examination has, however, shown, that auriferous sands exist in great abundance, and that platinum occurs more sparingly, and considerable attention has of late years been given to the skilful development of these mineral resources.

The results of these exertions have been most encouraging—this district now yields annually more than 12,000 lbs. of gold, and a small proportion of platinum, producing altogether the annual sum of £800,000 sterling to the government. A large proportion of the gold of the Ural is produced from exceedingly poor auriferous sands, like those of India ; and it has lately been found practicable to separate the gold by *fusion*, more cheaply than by the ordinary process of amalgamation by quicksilver. The economy of this expensive article in the reduction of the poorer ores of gold, is of course an important consideration.

With reference to this last operation—the extraction of the precious metal from its extraneous concomitants—it is deserving of remark, that a very interesting discovery has been made within the last year or two by M. Becquerel, the distinguished French chemist. It has been discovered by this philosopher that the electro-chemical agency may be employed in the reduction of the ores of the precious metals, as a substitute for the ordinary process of fusion or amalgamation; and it is highly probable that by this important invention this operation may shortly be economized, to an extent hitherto unattainable. In this case it will allow of the profitable working of auriferous sands, and ores, even poorer than any which have been described in this paper. It is not improbable, therefore, that this refined and important discovery, may constitute an entirely new era in the history and production of the precious metals.

IV.—*Observations on the Fossiliferous beds near Pondicherry, and in the district of South Arcot.—By* C. T. KAYE, ESQ. *Madras Civil Service.*

The existence of a bed of fossiliferous limestone in the neghbourhood of Pondicherry has long been pretty generally known to those who take an interest in such subjects, and some attention was recently attracted to it by several communications in the *Spectator* Newspaper. An observant person, indeed, can hardly fail of being struck with the nature of the stones which form the paving of some of the streets and the steps of many of the houses in Pondicherry, and which are replete, not only with the fragments of innumerable shells, but with many ostreas and other bivalves almost as entire as if they still reposed in their proper element. The silicified wood at Trivacary is also well known to the public from the beautiful polish which it receives, and from its adaptation to table and other ornaments. To the geologist it is interesting from the vast size of the petrified trees (one of which is nearly 100 feet long), from their great number, and from the perfect state in which these organic remains of other worlds are preserved.

It had long been a desideratum to collect data on which the era and nature of the formations which contain the fossils might be decided, and I accordingly took an opportunity of leisure in October last, to proceed to the spot with Mr. Cunliffe of the Civil Service. The time which we were enabled to devote to the investigation was unfortunately short,

and it might certainly have been committed to more scientific and experienced hands. I trust, however, that the facts which we were fortunate enough to collect were not altogether unimportant, and that, imperfect as our researches must necessarily have been, they may pave the way to more interesting discoveries.

Before proceeding further, I may as well mention, that, although the geology of India has generally been considered uninteresting on account of the absence of fossiliferous strata, Pondicherry is not the only locality in the south of the peninsula, where fossils are to be met with in abundance. In the inland district of Trichinopoly marine shells are also found imbedded in limestone, and the kindness of Mr. Onslow has put me in possession of several interesting specimens, of which notice will be taken hereafter.

The village of Seedrapett, the site of the shell limestone which is the subject of the present notice, is seven miles west of Pondicherry, and Trivacary is about eight miles to the west of Seedrapett. The form of the country may be characterized as an undulating plain : the limestone formation is flanked both on the east and west by one of the red sandy soil, which on the one side forms the low mounds of Trivacary, and on the other the " Red Hills" of Pondicherry, the latter being perhaps a continuation of the same formation which contains the silicified wood. If this be the case, it is evident that the limestone rests upon a basin or depression of the red sand, but owing to the absence of sections, and the imperfect means we had of ascertaining the position of the strata, this fact is by no means laid down as established, but is merely suggested as a point for future investigation.

The petrifactions of Trivacary have been often described, especially of late, it is only necessary therefore to state that they consist of numerous silicified trees, some of them of vast dimensions, resting more or less buried on low bare hills of a friable red sandstone. The hills are grouped in a circular form, and the petrifactions in many instances retain a perfect resemblance to the trunks of fallen trees. The red hills are bounded by others of a dark granite : the line of demarcation being very distinct. The trees, however, are not found reposing on the hillocks at Trivacary alone, but we observed them at a distance of at least three miles from that place, imbedded in the red sand, on the road to Seedrapett. We were totally unable to discover any other fossil, or any indication of such a thing, in the red soil which so abounds with the silicified wood.

There is a gradual descent from Trivacary towards Seedrapett, and the limestone commences immediately on the boundaries of the red soil:

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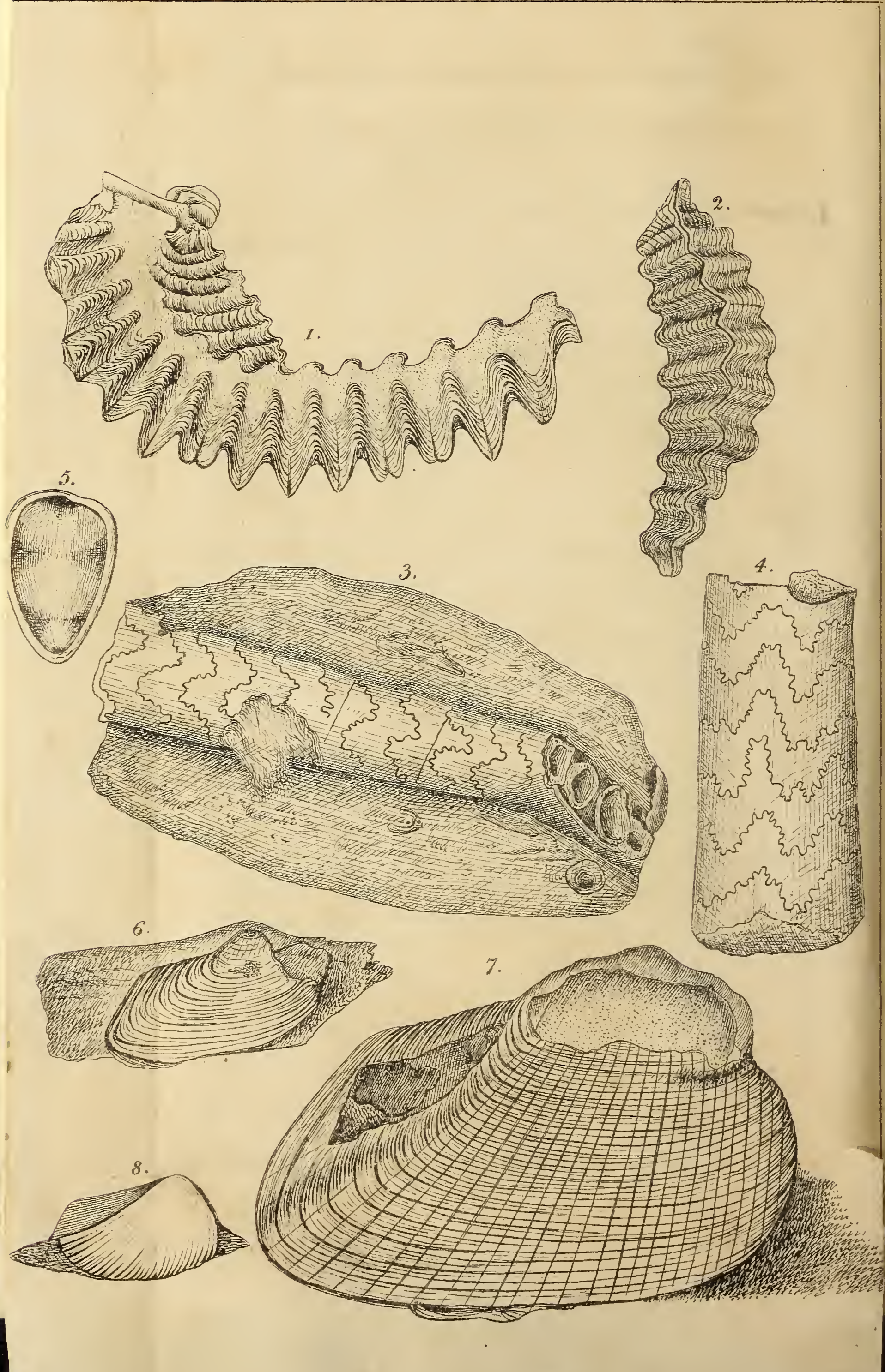

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it presents, as has been already stated, an undulating wavy surface, and the stone is found immediately below the turf, and sometimes even appears above it: it is quite hard, and is quarried in large blocks, though to no great depth, for the purposes before mentioned. It is almost every where replete with shells or other organic remains, which are in general so firmly imbedded in the hard stone that it is impossible to detach them:—the geologist, therefore, who would study with accuracy the nature of this deposit, should endeavour to reside for some period on the spot, many of the shells which are most perfect in the stone, not having yet been discovered in a separate state. In one situation, however, there are several small mounds of a whitish limestone, almost resembling chalk, where the surface having been abraded and decomposed by water, the shells which it contained have been separated, and lie scattered on the surface of the soil, among the debris of the containing rock: it was in this spot that most of the specimens here noticed were collected. I will now proceed to describe them in the order in which they appear in the Plates.

Pl. I. Nos. 1 and 2—*Ostrea carinata*—The identity of this shell with that figured by Lyell and other authors among the fossils of the European chalk cannot be doubted: they are very numerous at Seedrapett, and are found both in a separate state and imbedded in the rock, sometimes very perfect. No. 1 is slightly fractured at the point, but the linear marking, and even the sharp angles of the ribbing on the sides, are beautifully preserved, and the inner surface retains much of its polished enamel. No. 2 is a perfect specimen of the two valves adhering firmly together.

Nos. 3 and 4 are *Baculites*. This shell is called by Dr. Buckland a straight ammonite, and the same authority states that it is "found in the cretaceous formation alone." We collected many fragments of this shell on the surface of the soil, varying from three inches to half an inch in length: the most perfect specimen being imbedded in a rolled piece of limestone (No. 3), and owing to a longitudinal fracture displaying four of its chambers. All the specimens display the foliated markings at the junction of the walls of the chamber with the external shell: they are of a yellowish or reddish brown colour, and the interior is generally filled with beautifully crystallized calcareous spar. No. 5 is the transverse section of a baculite.

Nos. 6, 7, 8 are bivalve shells, probably referrible to the genus Cardium; they are represented about the natural size; 6 and 7 retain the shell itself and appear almost recent, but the interior of No. 7 is filled with

the limestone and fragments of shells cemented together sufficiently hard to take a polish. In No. 8 the shell itself has disappeared and left merely a cast in whitish limestone

Plate II. Nos. 1 and 2 are *Echini*, of the order *Spatangus*, common in the chalk of England. No. 2 is a small but perfect specimen. No. 1 is a portion of the external shell flattened out on the stone.

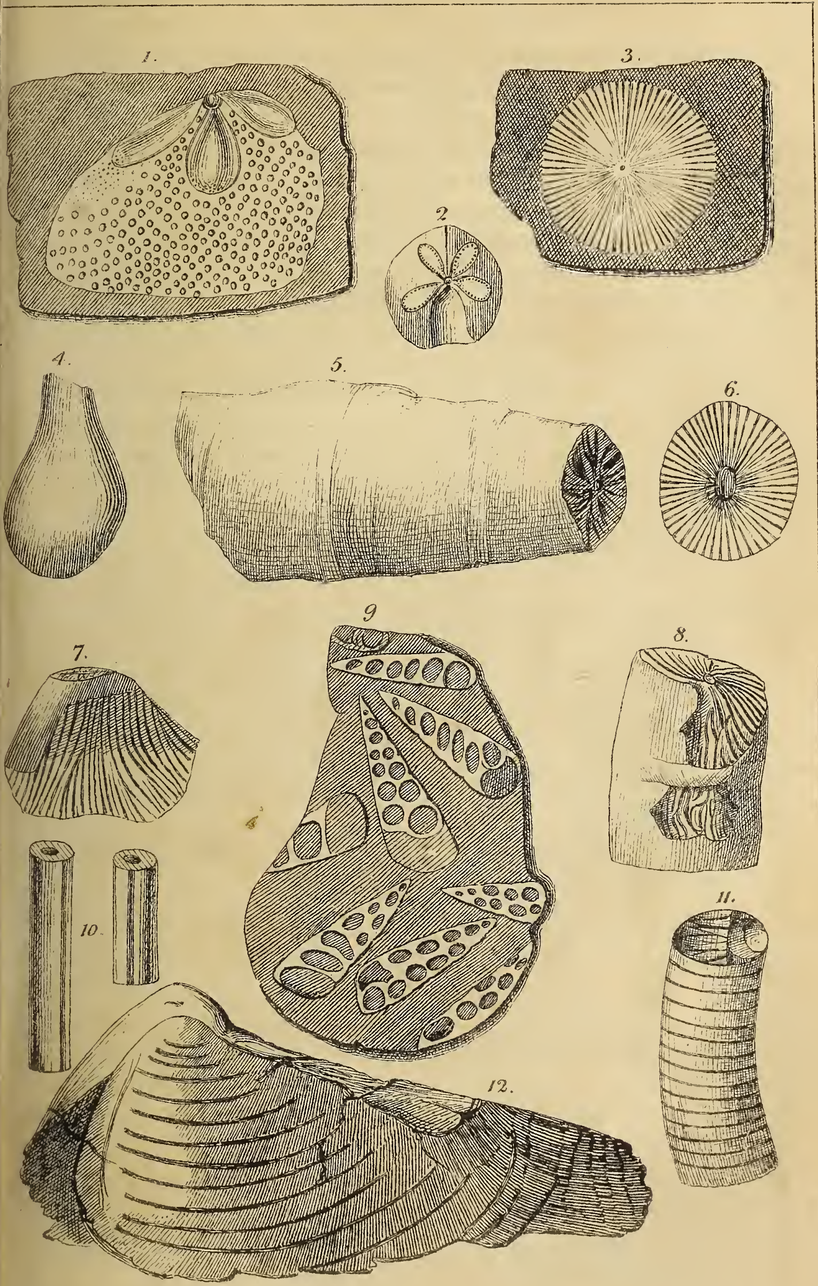
No. 3.—This is apparently the apex of a *Turbinolia*: it is not unfrequent in the limestone, and was sometimes found detached, in which case it precisely resembles the drawings of the *Turbinolia* given by Dr. Mantell, in his Geology of the South-east of Sussex, but is apparently of a larger species.

Nos. 4, 5, 6, 7, 8 are fragments of a zoophyte or coral with a pyriform body or termination, which is always found detached (No. 4); other fragments are cylindrical. This zoophyte seems to have consisted of numerous small lamellæ, converging *towards* the centre: but there was probably a cavity *in* the centre, which is now filled up with the chalky substance, as the lamellæ do not unite at the axis. No 6 shows the radiated appearance presented by the transverse section of a cylindrical joint or fragment, and 7 and 8 display the internal structure where it is laid bare by the decomposition of the external covering. These fragments are probably the joints of the stem or branches of the zoophyte, which may possibly therefore, have been the *Apiocrinites ellipticus*, but until more perfect specimens are found it cannot be named with any degree of certainty. The component matter of this fossil is carbonate of lime, and it effervesces freely with acid. They are found in great numbers close to the village of Seedrapett. We collected upwards of an hundred in about half an hour, and one of the best specimens I took out of the wall of a mud house.

No. 9 is a small mass of limestone, displaying on both sides beautiful sections of a multilocular shell, which Mr. Burr informs me is a *Turrilite*.

No. 10. A great number of small cylindrical bodies of this description were found, the longest perhaps 1½ inch in length, and about the thickness of a tobacco-pipe: they all have a longitudinal groove or sulcus, whence it may be inferred that they are a species of *Belemnite*, perhaps *B. minimus*; but it must be mentioned that, among the hundreds that were collected, and the still more numerous specimens that were thrown aside, not one was found which came to a point. Further research may, perhaps, supply this deficiency.

No. 11. Several casts of a slightly curved chambered shell, with annular markings, probably referrible to order of *Hamite* were found.



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The drawing represents the chamber as seen in the section, but the radiated marking is probably owing to crystallization.

No. 12 is a cast in limestone of a bivalve shell.

It is no easy thing to name fossils even to those who are most accustomed to geological researches, this department forming in general a separate branch of the science: many of the fossils, however, described in the above lines are of so marked a character, that in those instances where we have ventured to name them with any degree of certainty, we can hardly have been mistaken. I have not neglected either to consult those who were best able to give an opinion on the subject, and have also carefully compared the specimens with the best drawings and authorities I could meet with. To Mr. Frederick Burr, I am particularly indebted for the valuable assistance and information he has afforded me. If we do not err therefore very widely from the mark, we have, even on the information already obtained, very good *primâ facie* evidence that the Pondicherry beds are the equivalents of the upper secondary formations of Europe, and the fossils point especially to those of the chalk and greensand.

It is a well known fact that, during the formation of the cretaceous beds in England, a great quantity of silex held in solution by water must have been poured out; which, by the process of chemical affinity having collected around various organic nuclei such as corals, sponges and other zoophytes, has formed continuous and extensive layers of flint, interstratified with the chalk, almost every nodule of which contains and derives its shape from the enclosed remains of some organized body in a state of complete petrifaction. We observed no vestige of flints in the limestone at Seedrapett, and all the fossils collected there consist of carbonate of lime, and effervesce freely with acid; but the vast quantity of silicified wood, in the neighbouring formation of red sand, seems to point to some phenomenon similar to what must have existed during the deposition of the cretaceous beds of Europe.*

Lieut. Newbold, in the last number of the Journal, suggested that the fossiliferous beds of Pondicherry probably extended into the Verdachellum talook of South Arcot. I have made enquiries but have not yet obtained any evidence of this fact. Another interesting question, how-

* "Flints so commonly enclose the remains of sponges, alcyonia and other zoophytes, that some geologists are of opinion that the nucleus of every nodule was originally an organic body: that this has been the case in most instances is very evident: and in Sussex there are but few flints that do not possess traces of zoophytical organization."
Mantell's Geology of Sussex, 144.

ever, now suggests itself, viz, is the shell limestone at Seedrapett analogous and contemporaneous with that already mentioned as containing fossils in the Trichinopoly district? Sufficient data have not yet been collected to enable one to give a positive reply to this enquiry. The specimens which I have received from Trichinopoly consist of masses of limestone, very similar in character to that of Seedrapett, and containing innumerable small shells cemented together in the hard rock. Shells are, however, found detached from the stone, in general I should say in a more perfect state than those at Seedrapett.

Pl. III. No. 1, is a large bivalve from Trichinopoly: of which the shell is entire, with the exception of being chipped at the edges: it is filled with limestone.

Nos. 2 and 3 are intended to shew the nature of the shells contained in two small masses of the stone: the most perfect shells have been chosen for representation, but it was found impossible to figure the innumerable small shells and fragments of which the mass almost entirely consists. The shells in No. 2 are small turrilites, evidently of the same species as those represented in Pl. II. No. 9. Several specimens from the same locality, in Dr. Cole's possession, appear to me also to be turrilites, a fact which leads us to infer some analogy between the two formations, which further research will probably tend to demonstrate.

An interesting fossil from Trichinopoly in my possession is a piece of calcareous fossil wood, containing a number of petrified Teredines in crystallized carbonate of lime.

There can be no doubt that our knowledge of these beds is still very imperfect, and it may be supposed that it would have been better to have deferred the present notice until more accurate information should be obtained; but a temporary residence in Madras gave me an opportunity of consulting works to which I might not otherwise have had access, and also afforded facilities for getting up the drawings, &c. connected with the publication, which I was the more unwilling to neglect, as they might not speedily recur.

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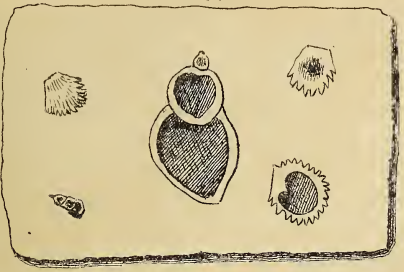

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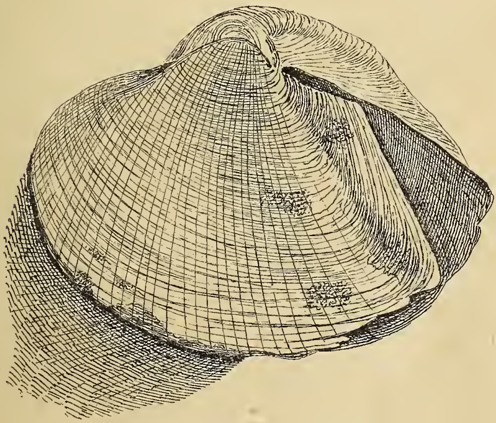

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V.—*Remarks on the Fruit of the Natural Order Cucurbitaceæ.—By* Robert Wight, M. D., F. L. S. &c.

The order *Cucurbitaceæ*, is perhaps one of the most curious and inexplicable in the system of plants, and though at different times much studied by several eminent botanists, is still imperfectly understood; at least if we may judge from the fact, that no two writers on the distribution of plants according to their natural affinities seem to agree as to what families are its nearest allies. It is not now my intention to examine this question, for which, indeed, I have not at present leisure, even supposing I possessed the requisite materials, which I do not, but merely to offer a few observations on the general character of the family and fruit, introductory to a conspectus of the genera of the order, with which Dr. Arnott kindly favoured me, and at the same time permitted me to place on the pages of the Society's Journal, should I deem that desirable. Deeming the conspectus really a most desirable addition to our Indian botanical literature, I have much pleasure in submitting it for that purpose, in the hope that the Society may be of the same opinion.

The *Cucurbitaceæ* are a tribe of plants so very unlike the rest of the vegetable kingdom, that I think I may safely say no one having the slightest knowledge of family likeness among plants, could ever mistake so far as to refer one of them to any other family. Though thus isolated from all around, and without a single near relation with whom they can be justly compared or confounded, they yet stretch their more remote affinities on all sides; hence the difficulties which systematic writers find in decisively referring them to any one place, more than another, in the series of orders. Nearly all however, now agree in placing them among orders having parietal placentæ, that is, among plants the ovary of which is one-celled.

To any one who will take the trouble to look attentively at a slice of a young cucumber this must appear strange, but is yet not the less true. In one of the latest and the best introductions to botany in the English language, Dr. Lindley's, a peponida, the peculiar fruit of the order, is thus defined :—" One-celled, many-seeded, inferior, indehiscent, fleshy; the seeds attached to parietal pulpy placentæ. This fruit has its cavity frequently filled at maturity with pulp, in which the seeds are imbedded; their point of attachment is, however, never lost. The cavity is also occasionally divided by projections of the placentæ into spurious cells, which has given rise to the belief that in *Pepo Macrocarpus* there is a central cell, which is not only untrue but impossible."

Dr. Arnott in the article Botany, Encyclop. Brit. Ed. 7, gives a different account of it, but still, it appears to me, far from a correct one, namely :—" A *pepo* or *peponida* is a fleshy inferior fruit, either indehiscent or bursting irregularly, and consisting of about three carpels, each of which is divided into two cells by its placentiferous margin, being so introflexed as to reach the dorsal suture. The sides of the carpel, and even sometimes the introflexed portion, usually become extremely thick and fleshy, forming the great mass of the ripe fruit, so that by losing the general character of dissepiments, they might almost be said to disappear, and thus at first sight a pepo would be said to be, and has been so described, a 1-celled, fleshy, indehiscent fruit, with parietal placentas, that send out sometimes false dissepiments towards the axis, as the cucumber and gourd."

This view, therefore, is essentially different from Dr. Lindley's, for, according to Arnott the placentæ are virtually central, not parietal. The only difference between a pepo and an apple being, according to him, that the placentiferous margins of the carpellary leaf are introflexed, and extend outwards nearly to the parietes of the fruit, in place of remaining in the axis. Lindley on the other hand views a pepo simply as a one-celled fruit with parietal placentæ, the cavity being occasionally divided into spurious cells by projections of the placentæ. Neither are altogether consonant with appearances, though that of Arnott appears the most so; but both, in common with all others that have yet been promulgated, are incorrect both as to theory and fact.

While our ideas of the structure of the most essential organ of the plant, with reference to natural affinities, are thus vague, can it be matter of surprise that we are unable to trace its relations, and determine its affinities in the system of plants ?

What then is a peponida ? I have said above that it is neither a one-celled fruit with parietal placentas, nor a three-celled one with introflexed central placentas. But before I can say what it is, and point out the difference between it and a fruit of the usual construction, it is necessary to state what the usual structure is. This I shall do by means of a short extract from Lindley's Key to Structural Botany.

354. " A Carpel is formed by a folded leaf, the upper surface of which is turned inwards, the lower outwards ; and the margins of which develope one or a greater number of buds, which are the ovules.

355. When the carpels are stalked, they are said to be seated upon a *thecaphore*, or *gynophore* ; *Ex.* Cleome, Passiflora. Their stalk is analogous to the petiole of a leaf.

355. *a.* When the carpels are all distinct, or are separable with facility, they are *apocarpous* ; when they all grow into a solid body, which cannot be separated into its constituent parts, they are *syncarpous.*

356. The ovary is the lamina of the leaf.

357. The style is an elongation of the midrib (174)

358. The stigma is the denuded, secreting, humid apex of the midrib.

359. Where the margins of the folded leaf, out of which the carpel is formed, meet and unite, a copious development of cellular tissue takes place, forming what is called the *placenta.*

360. Every placenta is therefore composed of two parts, one of which belongs to one margin of the carpel, and one to the other.

361. As the carpels are modified leaves, they necessarily obey the laws of arrangement of leaves, and are therefore developed round a common axis.

362. And as they are leaves folded inwards, their margins are necessarily turned towards the axis. The placentæ, therefore, being formed by the union of those margins, will be invariably next the axis."

From this we learn, in few words, that the carpellary leaf is always so folded that its midrib is towards the circumference, or forms the dorsum of the cell or carpel, while the placentiferous margins are placed in the axis; that the difference between a one-celled and many-celled fruit, merely consists in the placentiferous margins of the carpellary leaves of the former not extending inwards to the axis, but stopping in the circumference and bearing their ovules attached to the walls of the cell—hence *parietal.* This position of the carpellary leaf is so constant, that the possibility of an inversion of this order of things in a pepo seems never to have entered into the calculations of any one of the numerous botanists who have given their attention to the investigation of the structure of this curious fruit; and yet such is simply the case. In a pepo the normal position of the midrib of the carpellary leaf is reversed, that is, is placed in the axis, and the placentiferous margins towards the circumference. That such is actually the case requires no argument to prove; we have only to cut the ovary of any true cucurbitaceous plant to be made sensible, at a glance, that it is so: though I confess that in none have I seen it so clearly made out as in *Coccinia Indica*, owing to the carpels of that species remaining distinct, merely held together, not as usual by cohesion between the respective carpels, but by the tube of the calyx in which they are enclosed. Did I wish to illustrate the theory by means of a diagram, I could not devise one more perfect than a simple section of the ovary of that plant, merely extending the natural divisions, by dividing the calyx, so as to allow each of the carpels to

be slightly separated in the representation, to facilitate the demonstration. This, however, is I think even unnecessary, for with the clue to the true structure, which this species furnishes, there can no longer be any difficulty in understanding it from the examination of any genuine species of the order.*

What effect this new exposition of the structure of the ovarium may have on the determination of the affinities of this order, I am, up to the present time, quite unprepared to say: but of this I feel certain, that, in so far as structure is concerned, they are as far removed from all their now reputed allies, as their peculiar habit removes them from all the parietose families, except *Passifloræ*, among which Bartling, Endlicher and Lindley have placed them. This very unusual structure, in short, marks them as a peculiar order, the affinities of which have still to be sought for.

I am equally unprepared to say to what extent this unlooked-for structure may influence our views in regard to other anomalous orders, especially those with solitary carpels: since, having established the fact that the usual structure may be inverted, it will naturally lead to new investigations, which may prove, that the solitary carpels of *Leguminosæ* are not, as now supposed, necessarily the result of constant abortion of one of two carpella, but may be explained on some other theory more consonant with the, almost invariably observed, structure in that large and interesting order; which, like *Cucurbitaceæ*, stands an isolated family in the system of plants, through this one remarkable peculiarity,—a peculiarity so constant, in this tribe, that it goes far to prove the existence of that botanical nonentity, a terminal leaf. But, being unprepared to offer any matured opinions on these points, I forbear further speculation, and shall at once proceed with the conspectus; trusting, however, ere long, to be able to re-enter more at large on the consideration of this interesting enquiry.

The subjoined remarks, I copy from the article *Cucurbitaceæ* in my forthcoming Number of the Illustrations of Indian Botany.

" The following explanatory extracts from the letter which accompanied the Conspectus, may not inappropriately be introduced.

" ' I have lately been revising our East Indian *Cucurbitaceæ*, in consequence of Schrader's paper in the Linnæa, vol. 12. At first I was inclined to consider it worse than useless to subdivide old genera, especi-

* After this paper was in the printer's hands it was suggested that some illustrations were desirable to render the verbal description more easily understood. The accompanying figures representing the three different forms of ovaries—1-celled with parietal placentæ; several celled with central placentæ; and a Peponida; were therefore prepared,

ally *Bryonia*, as he has done; but when I came to consider his sectional characters, and that the form and position of the stamens and anthers and stigma and fruit are, really, the only characters hitherto employed for genera by other botanists; and that all Schrader has done, is to keep only those species in their old genera that agree with the character and turning out, and making new genera of those that do not, then I felt inclined to go great lengths towards adopting his views. I intend here to give you a Conspectus, or abridged generic characters, which I have drawn up, not only for the Indian, but also for the whole world, which I shall not object to your publishing as "abridged characters of the genera of the tribe *Cucurbiteæ* of Schrader.'

"At the conclusion of the conspectus he continues,—'These seem to be all the genera known that truly belong to *Cucurbiteæ*, they have all unisexual flowers. *Gronovia* has them bisexual, but is otherwise very closely allied. *Allasia* cannot be of this order, unless we suppose the description quite erroneous; and if so, Loureiro may have had before him, in part at least, the *Telfairia pedata*; *Myrianthus* cannot belong to *Cucurbitaceæ*.

"'*Thladianthus Runge* is imperfectly described as to the stamens, but may perhaps form a 7th tribe.

"'I have laboured under great difficulty in making out these characters, partly because the published descriptions were very imperfect, partly because I had not several of the genera, and partly, from the extreme difficulty of examining the anthers after being dried and pressed. I would therefore suggest to you and other Indian botanists, to re-examine all the Indian ones on living plants, and have drawings made, paying particular attention to the representation of the anthers.

"'At first you may, as I did, confuse section 7 with section 9, but if you will compare the flower of *Citrullies*, *Momordica* or *Lagenarea* with *Cucurbita* or *Coccinia*, you will readily see the difference. In section 7, the connectivum is lobed, and the anther cells are placed along the edge of the lobes—in sections 8 and 9 the connectivum is not itself lobed, but the anther cell is bent,' (it winds upwards and downwards along the back of the connectivum).

"Warned by the concluding paragraph of the difficulty attending the description of these plants from dried specimens, I took occasion, as opportunity offered, to compare some of the sectional characters with recent specimens, and feel disposed to think the sections too numerous, and not sufficiently distinguished. I have not yet succeeded in comparing the whole, but would suggest the following alterations, which I think would improve the arrangement.

" Section 6 might with advantage be suppressed, and its only genus referred to section 5. Sections 7 and 9 would be better united, the anthers being the same in both; transferring, however, *Cucurbita* to section 8, on account of the anthers, which are similar to those of *Trichosanthes*, making the insertion of the filaments a matter of secondary consideration, a generic not a sectional distinction.

" The difference between sections 7 and 8 would then be—not that in the former the anther is lobed and in the other entire, but that in section 7 the back is traversed by an elevated gyrose ridge, on the top of which the long gyrose anther is placed, while in section 8 there is no such elevation, the anther cell being sunk into the substance of the connectivum, not elevated on a ridge with a deep furrow between each bend. To this may be added that the connectiva in section 8 is elongated; hence, from the union of the three, a cylinder results, while in the other their union produces a sort of capitulum.

" *Bryonia Garcini*, doubtfully referred to *Bryonia*, is a new species of *Pylogyne* : *Bryonia leiosperma*, I find, from the examination of dried specimens, is a second species of *Mukia*, with which it agrees well in habit.

" Notwithstanding these differences of opinion, it is not my intention to alter the conspectus, but print it simply as it reached me, the few additions I have to make, being included within brackets—thus [ ]. Before proceeding further it may be well to explain what is meant by the term tri-adelphous, as applied to this family, which is of such frequent occurrence in the following characters. The normal structure of *Cucurbitaceæ* is to have five stamens, in place of which we usually find only three; but when these are carefully examined it appears that two of them are twice the size of the third, and are actually made up of two united: each set is then called an adelphi or brotherhood, and the three together tri-adelphous This structure is readily seen in the *Pekunkei* (*Cucumis acutangulus*, Ainsley) where the anthers do not cohere. In those where they do cohere it is not so clearly seen, as they then require to be separated artificially before it can be made out.

" In some genera the anthers are described as being one or two-celled; these characters require to be used with caution, as being generally of very difficult application in practice. Theoretically every anther is two-celled, and here in examining a number of instances with particular care, under a high magnifier, I have found most of them actually two-celled, though on less careful examination they appeared only one-celled. If such is the case when examined with fresh specimens, how much more liable to error must we be when working with dried ones.

CONSPECTUS OR ABRIDGED CHARACTERS OF THE GENERA OF THE TRIBE CUCURBITEÆ* OF SCHRADER.

§ 1.—*Filaments 5, inserted on the throat of the corolla; anthers distinct or 3-adelphous, anticous, straight; fruit baccate, few seeded.*

1 Coniandra (Schrad.). Corolla 5-partite: connectiva conniving, oblong, conical: fruit beaked. *South Africa.*

2 Cyrtonema (Schrad.). Limb of corolla 5-partite: filaments 5, incurved, connectiva incrassated 3-adelphous; anthers fixed laterally under the apex. *South Africa.*

§ 2.—*Filaments di or tri-adelphous, inserted on the tube of the corolla; anthers lateral, straight, 2-3-adelphous.*

3 Sicydium (Schlecht). Corolla 5-petaled, petals undivided: filaments 3-adelphous, dilated and incurved at the apex; anthers without a beak. *Mexico.*

4 Bryonopsis (Arn.). Corolla 5-partite, lobes obovate, entire, undulated: filaments 3-adelphous, inserted on the throat, straight; anthers pointless: stigma fringed: berry few seeded. *East Indies—Courtallum.*

5 Achmandra (Arn.). Lobes of the corolla undivided: filaments tri-adelphous very short; anthers anticous, inserted along the margins of the connectivum, linear oblong; connectivum prolonged into a short beak beyond the anther: fruit baccate (always?) beaked. *East Indies. Bryonia epigæa, rostrata, deltoidea, and an undescribed species from Malabar.*

Obs.—Perhaps this and the two last genera might be joined to Melothria.

6 Melothria (Linn.). Lobes of the corolla undivided, denticulated: filaments 3-adelphous; connectivum pointless: fruit baccate, not beaked. *America.*

Obs.—Schrader notices an East Indian one, but that may perhaps be an *Achmandra.*

7 Ceratosanthes (Schrad.). Lobes of the corolla linear bifid: filaments 3-adelphous. *America.*

8 Anguria (Linn.). Lobes of the corolla entire: stamens diadelphous: fruit somewhat 4-angled. *America.*

§ 3.—*Filaments 3-adelphous inserted on the top of the tube, anthers all*

* This tribe contains all the East Indian genera except *Zanonia*—Schrader refers *Erythropalum* of Blume to Cucurbiteæ but that genus is very closely allied to *Mackaya* (Arnott in Jardine's Mag. of Zool. and Bot. vol. 2) and does not belong to the order.

cohering by means of their connectiva, and applied at the back along the margins of the connectiva sigmoid. (?) two-celled.

9 Schizostigma (Arn.). Style simple, stigma, peltate, fleshy, cleft into 10-12 radiating linear lobes. *Andes of Mendosa.* (*Cucurbita asperata.* Gill.)

§ 4.—*Filaments distinct or tri-adelphous, inserted on the throat of the corolla, anthers* 6 *or* 3*-adelphous, gyrose, anticous.*

10 Sphenanthe (Schrad.). *Mexico.*

§ 5.—*Filaments tri-adelphous, inserted at the base of the corolla, anthers lateral, straight,* 3*-adelphous.*

11 Pilogyne (Schrad.). Calyx campanulate; segments of the corolla patent, much longer than the calyx: anthers one-celled: style entire; stigma 1, pileate: fruit baccate, few seeded, obtuse. *South Africa.* [*East Indies—Bryonia Garcini ?*]

12 Zehneria (Endl. ?). Lobes of the corolla quite entire: style trifid; stigmas 3, flabelliform, quite entire: fruit baccate, few seeded, blunt. *South Africa, East Indies* and ? *Norfolk Island.—Bryonia Mysorenses. B. Hookeriana.*

Perhaps this is only a subgenus of *Pilogyne.*

13 Karivia (Arn.). Calyx urceolate, corolla scarcely exserted, lobes minute, quite entire; anthers two-celled; style entire; stigma pileate, 3-fid: fruit a peponida, many seeded, blunt or with a short thick beak. *East Indies, Bryonia umbellata. B. amplexicaulis.*

14 Rhynchocarpa (Schrad.). Lobes of the corolla denticulate, ciliated; style trifid; stigmas 3, jagged and toothed: fruit with a long slender beak. *Guinea.*

§ 6.—*Filaments tri-adelphous, inserted at the base of the corolla, anthers all cohering, posticous, linear, straight.*

15 Mukia (Arn.). Style entire, stigmas 3, more or less cohering, erect. Anthers distinct, one-celled, lateral; [connectivum prolonged, forming a projecting point: a globose abortive ovary in the bottom of the calyx.] *East Indies—Bryonia scabrella.* [*B. leiosperma.*]

§ 7—*Filaments* 5, *or tri-adelphous, inserted at the base of the corolla; connectiva toothed or lobed, anthers applied at the back along the margins of the connectivum, and therefore flexuose, gyrose, or anfractuose.*

16 Bryonia (Linn.). Corolla 5-cleft: anthers tri-adelphous, one celled: style trifid; stigmas subreniform or bifid: fruit ovoid or globose, baccate; few seeded. *Europe* and *East Indies—B. laciniosa,* India. *B. alba. B. dioica,* Europe. Perhaps also *B. Garcini* and *leiosperma,* but of these I have no male flowers by me to examine [*B. Garcini.* Stamens tri-adelphous one-celled: cells linear, marginal, not sigmoid, anticous: style one,

stigma dilated, peltate: ovary few seeded; pepo inverse reniform, 2 seeded. This is probably a new genus, but if not seems to belong to *Pilogyne* rather than any other here. It cannot possibly belong to *Bryonia.*]

In the European plants, the type of the genus, there are 2 ovules in each of the 3 cells of the ovary—nearly all Blume's species belong to other genera.

17 Citrullus (Schrad.). Corolla persistent, 5 parted, subrotate: anthers tri-adelphous, bilocular: style 3 fid; stigma obcordate, convex: fruit a fleshy or dry and fibrous, many seeded peponida. *Africa, East Indies. Cucurbita citrullus* and *Cucumis colocynthis.*

18 Ecbaliam (Rich). Corolla 5 cleft: anthers tri-adelphous: ovules in two rows in each cell; stigmas three, two horned: fruit an elastically and irregularly bursting peponida. *Europe—Momordica elaterium.*

19 Momordica (Linn.). Petals 5, adnate to the base of the calyx, deciduous: anthers all cohering: ovules in a single* row in each cell; stigma two lobed; fruit a capsular, elastically bursting, 3 valved peponida. *E. Indies, South Africa* and *America.*

[*This though practically correct is not theoretically so, the carpellary structure being the same here as in others; each margin has its placenta and ovules: and though at any one section only one row appears, we do not find the ovules always attached to the same line of placenta on slicing the ovary successively from end to end, but sometimes on the one, sometimes on the other side of the cell; such at least I find it in *Momordica Charantia.*]

To this genus seems to belong, *Muricia,* Loureiro and *Neurospermum,* Raf.

20 Luffa (Cav.). Petals 5, inserted in the base of the calyx, deciduous: anthers all distinct or di-triadelphous: style 3 fid; stigma reniform or bipartite: fruit a peponida, at length dry and internally fibrous, usually opening by a terminal lid, rarely indehiscent. *East Indies* and *Arabia.* There are 3 sections of this genus.

1st. Stamens distinct, *Luffa pentandra, acutangula,* and *Kleinii.*

2d. Stamens 3-adelphous. *L. amara,* Roxb. and nearly all the species of *Turia,* Forsk.

3d. Stamens di-adelphous—*L. tuberosa,* Roxb.

21 Benincassa (Sav.). Corolla (yellow), five parted, patent: anthers 3-adelphous: style undivided, very short; stigma large, thick, irregularly lobed and plaited: peponida, fleshy indehiscent. *Asia.*

22 Lagenaria (Ser.). Corolla (white) five petaled: anthers 3-adelphous: style almost none; stigmas 3, thick and 2-lobed: peponida fleshy and indehiscent. *India, South Africa.*

§ 8.—*Filaments, 3-adelphous, inserted on the tube of the corolla; connectiva entire, anthers 3-or mon-adelphous, posticous, linear, bent upwards and downwards: calyx long, tubular.*

23 Trichosanthes (Linn.). Segments of the corolla lacerated and fringed: anthers 3-adelphous? or all united: style trifid; stigmas oblong, subulate: fruit a peponida, many seeded. *E. Indies.*

[In all the species I have had an opportunity of carefully examining, the anthers are monadelphous or united. The style is not trifid, nor properly speaking the stigmas subulate, as they cohere nearly to the apex by their central face, though the stigmatic surface extends for some distance outwardly, and presents a somewhat subulate outline.]

I reunite *Involucrarea* to this as a mere section depending on the bracteas, the character taken from the anther not holding good, at least *T. Cucumerina* has frequently the anthers all united, and I suspect also *T. Anguina*; perhaps they only become tri-adelphous after fecundating.

[In *T. Anguina* they are never tri-adelphous, the anthers cohere to the last as represented in the accompanying figure. This last species with *T. globosa*, and *trifoliata*, Blume, and *Involucrarea*, Serange (*T. Wallichana*) form a very characteristic section, perhaps a subgenus, distinguished by their curiously bracteated male flowers]. R. W.

24 Gymnopetalum (Arn.). Calyx constricted at the mouth: corolla (yellow) 5 parted; segments quite entire: anthers all closely cohering: fruit baccate, ovate, beaked, few seeded: seeds large, roundish, with a blunt margin *E. Indies.* There are two species—

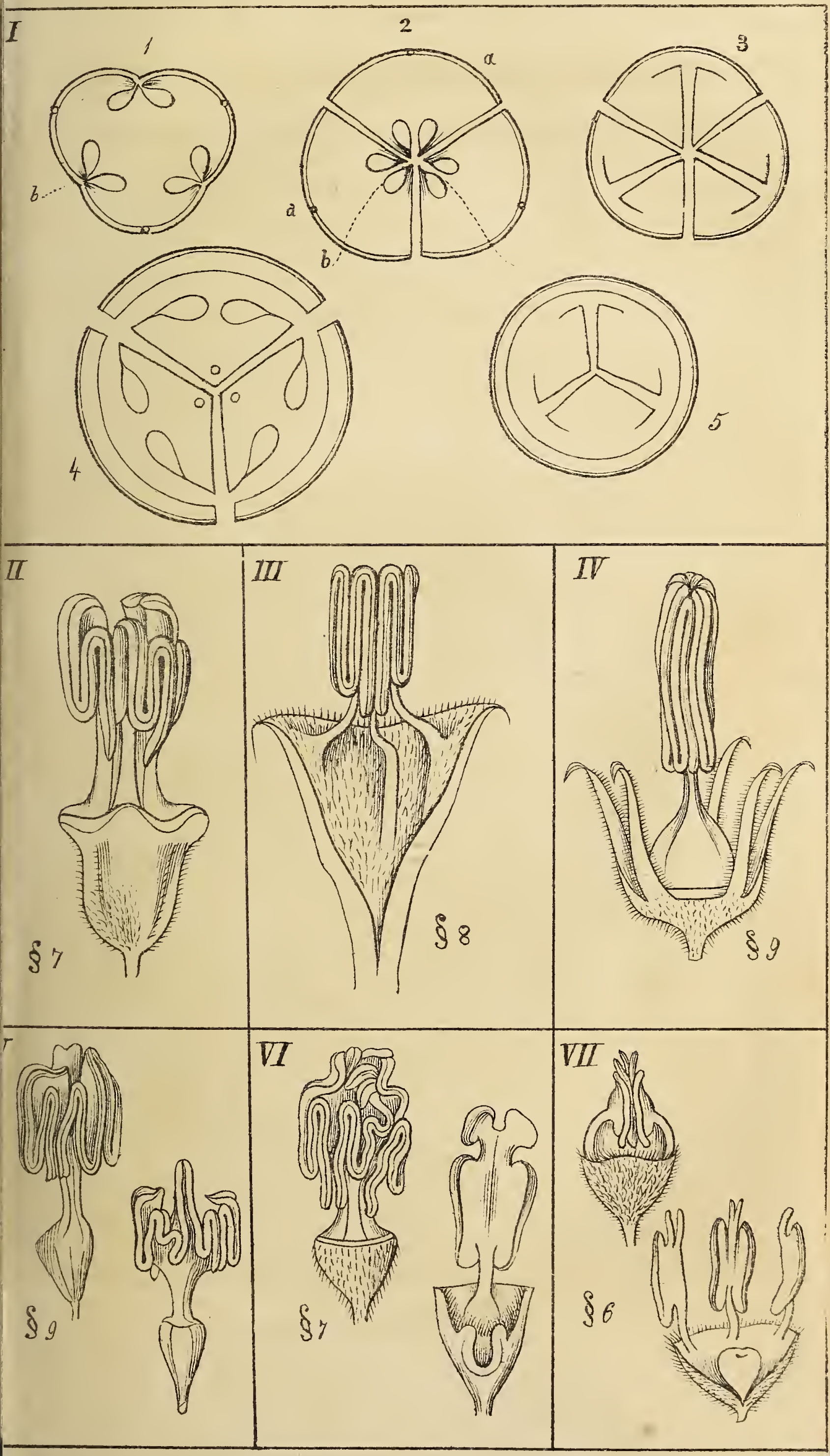
1 *G. Ceylanicum* (Arn.). Leaves deeply 5 lobed; perianth glabrous: *Bryonia tubiflora.* W. and A.

2 *G. Wightii* (Arn.). Leaves 3-5-angle-lobed; perianth hairy. *Courtallum.*

§ 9.—*Filaments usually tri-adelphous, inserted at the base of the perianth; connectiva entire, unless when produced into appendages beyond the anthers; anthers linear, posticous, bent upwards and downwards (calyx campanulate or rarely infundibuliform.)*

25 Cucumis (Linn.). Corolla 5-parted: anthers tri-adelphous, or all of them slightly cohering, with appendages at the apex! Peponida fleshy, indehiscent, or rarely irregularly dehiscent, polyspermous: seeds ovate, compressed, sharp edged. *Asia, Africa* and *America.*

26 Cucurbita (Linn.). Corolla campanulate, 5-cleft: filaments triadelphous at the base or quite monadelphous; anthers all cohering, without appendages: peponida fleshy, indehiscent, polyspermous: seed with a slightly thickened edge. *Asia and America.*


I
1
2
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a
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§ 9
VI
§ 7
VII
§ 6

NATURAL HISTORY

27 Elaterium (Linn.). Petals scarcely united at the base: filaments monadelphous, anthers all cohering: style thick; stigma capitate: fruit a coriaceous, one-celled, few seeded capsule, bursting elastically by two or three valves. *America.*

28 Schizocarpum (Schlch.). Corolla infundibuliform, quite entire: filaments 3-adelphous: anthers all cohering; peponida many seeded, bursting by several valves that cohere by their apex. *Mexico.*

29 Coccinea (W. and A.). Corolla campanulate, segments acuminated: filaments monadelphous, anthers tri-adelphous, conniving, without appendages: peponida somewhat baccate, many seeded. [Usually of an oblong oval shape and bright red when ripe]. *East Indies.*

§ 10.—*Filaments monadelphous, connate into a column, which is capitate at the apex, and then bearing the gyrose posticous anthers.*

30 Cephalandra (Schrad.)· *South Africa.*

EXPLANATION OF THE PLATE.

Fig. I.—1. A tricarpellary one-celled ovary—that is, the placentiferous margins of the carpellary leaves meeting in the circumference, and bearing their ovules on the walls or parietes of the cell.

a Supposed position of the midrib—*b* placentæ parietal.

2. A tricarpellary 3-celled ovary, the laminæ of the carpellary leaves folded inwards, until they meet in the axis, and there produce ovules.

a Supposed position of midribs—*b* plantæ axillary.

3. An imaginary section of a pepo explanatory of Dr. Arnott's theory of its construction; copied, but with some modification, to render it more explanatory, from his figure in the Encycl. Brit.

a Supposed position of the midrib—*b* the placentiferous margins represented introflexed, reaching nearly to the dorsal suture, dividing the carpel into two cells.

4. Section of the ovary of Coccinea Indica; the calyx divided in the line of the partitions of the carpella, by which they are permitted to fall apart.

5. Section of the same; the parts *in situ.*

Fig. II.—Section 7. Momordica Charantia.
III.—Section 8. Trichosanthes anguina.
IV.—Section 9. Cucurbita maxima.
V.—Section 9. Coccinea Indica.
VI.—Section 7. Lagenaria vulgaris.
VII.—Section 6. Mukia scabrella.

Obs.—These dissections have been prepared with the view of showing that sections 7 and 9 are not distinguishable by the characters assigned—the anthers being lobed or entire—and that, by taking our characters rather from the form of the anthers than the insertion of the filaments, Trichosanthes and Cucurbita might be advantageously placed in the same section, leaving the character taken from insertion available as a generic distinction between them.

VI.—*Notices of some Roman Catholic Books, existing in the Telugu Language.—By* C. P. Brown, *Esq.*

The Roman Catholic Missionaries, who visited India about the year 1600, were diligent in instructing the Telugus; and their efforts are briefly described by Navarette, one of their number, who, after being employed in China, was transferred to India and subsequently to South America.

The Abbé Dubois gives no very complimentary account of the success of the Catholic Missionaries among the Tamils. The *imitation of the Vedas*, written in Sanscrit, under the guidance of *Robertus de Nobili*, has been described by Mr. Ellis, in the Asiatic Researches; and it is to be wished that a sketch could be obtained of all the Roman Catholic treatises existing in Tamil: some of which have been noticed in the last number of this Journal, in the Memoir of Beschi. Those which are written in Telugu, will now be described. There may perhaps be others: but such are unknown to the native christians who obtained for me the following few volumes.

One of these is a translation or abridgment of the Old Testament history: this is written in a clear and easy style, and may be useful to those who are beginning to study Telugu. It is evidently translated from the Latin Bible: and the ten commandments are arranged as they are in English Bibles.

The version of the Gospels forms a separate work; it is a *Harmony* or selection of chapters, taken from the different Evangelists, so as to form a continuous narrative. Some Romish legends are interspersed; particularly those regarding the Virgin: and paraphrastic remarks are mingled with the text: thus, the Lord's Prayer is quadrupled in length.

The dialect used in these works is very respectable. A few *Italian* words are used; as *Sancto spirito*, and *Pascha*, with *Baptismum*, and

Baptista; there are also a few Hindustani expressions. There is in some passages an appearance of a foreigner's composition, but in general the style is unobjectionable, unless as being a little pedantic.

These books (all unprinted) are usually styled the *Veda:* and those who desire to obtain them should enquire for them under the name of the *Christian Veda.* But the New Testament is often denominated *Suvisesham:* which denotes Good News. It is to be observed that in the Gospels the *doctrinal* portions are usually omitted.

Another volume much read among natives is usually called *Jnana Bodha*, or Instruction in Wisdom, but I do not find any title in the volume. It is a mere set of sermons on various doctrines, wherein there are many allusions to history (even including a notice of *Cæsar Borgia*) but there are few references to the Bible. It is not well written or interesting An European reader, if acquainted with Telugu, will understand it with ease: but to the natives it is extremely obscure.

There are some trivial compositions which call for little notice: such as the *Devara Talli Dandacam*, or "Chant to the Mother of the Lord." Another hymn or chant is denominated *Jesu Natha Swami Dandacam.*

There remain two volumes which call for more notice, being the *Tobhya* Charitra and the Vedanta Rasayanam. These are written in verse.

The first of these is the legend of Tobit: written in *padya* metre, and contained in three cantos. It is an amplification of the story described in the Apocrypha, and possesses no great literary merit. It is the composition of *Pingala Ellaya*, the son of Mágaya, whom the introduction shews to have been a Jangam. The Jangams narrate regarding their teacher Basava, a variety of legends; part of which, particularly those describing his birth are mere imitations of the first book of the Ramayan: and these stories are in the present poem related regarding Tobit.

The Vedanta Rasayan is entitled to more particular notice: like the poem last mentioned it is in the *padya* metre, or stanzas, and is the composition of Ananda, son of Timmaya, of the Mangalagiri family: the style is purely classical; and judging from circumstances we may consider it to have been written about a century ago. The author's poetical powers are considerable, the taste he shews is good; and the extent of his learning, particularly in Sanscrit, and the classic dialect of Telugu, has gained him much applause. His poem which we may denominate *A summary of the Gospels*, has been mentioned in a former essay, but it merits a more detailed notice. In the usual mode pursued by Catholic writers it describes the five *sorrowful*, and the five *joyful mysteries*, and omits much of the di-

dactic portion. The expressions *Spirito Sancto*, *Baptismum*, &c., are retained. The four books with the introduction contain nearly 4000 lines.

The first book opens with a prayer for the divine blessing on the poet's patron. Precisely following the braminical method, he now describes the family of his patron and that of *Mallarusu*, who is the pupil or questioner: the replies given by the teacher constituting the poem. This mode has been followed by Principal MILL, in his Sanscrit poem, entitled "CHRISTA SANGITA."

The preface being concluded (in 260 lines) the author gives an introduction, which seems superfluous; describing the occurrence of an eclipse: a conversation regarding which leads to the real theme of the poem. Mallarusu applies to a hermit named *Parvataya*, or, *Jnána Bodha Muni*, who undertakes to describe the christian religion. As a preliminary, he attempts to describe Deity, and refutes the braminical ideas on this subject; he urges the adoration of God alone. He next describes creation: and the nature of angels. The fallen angels, and the devil as a tempter. These subjects are treated partly in the style of the Latin theologians and partly in a new method such as a native of India might be expected to devise. The system of Hindu idolatry is next combated, and several of the absurd braminical legends are very justly weighed. At the close he says "Let us then desist from regarding Siva, unless in the light of a foe: and let the emblems of such false gods be laid aside."

The second book opens with a benediction in the name of Christ The poet now describes creation. His description of Eve's beauty is quite in the Hindu style, though free from grossness An exuberant description of Paradise. The forbidden fruit. The Temptation and Fall. Then follows a discussion on the origin of evil.

The poet avoids mentioning that Adam and Eve were naked—that the devil was in the serpent's form;—that the curse was inflicted—that Cain slew Abel: indeed he throughout the work passes over in silence whatever he thinks might deter a Bramin from reading his poem.

He now passes to the history of Abraham, then to the birth of the Holy Virgin "who lived with Joseph as with a brother." The birth of Saint John. The Annunciation. The naming of John, and the birth of Our Lord, are described in full detail, and in a very poetical style, (but the circumcision is not mentioned). The hymn sung by the Angels is well executed. The birth is stated to have taken place "in the

month Margasira" which answers to December. Here arises a question why the Lord was born not in a palace, but in a stable. The coming of the " Three kings." The alarm of Herod. The interview with Simeon. The flight to Egypt. The disputing with the doctors in the temple.

The third book (which the student should peruse *first*) contains about 1000 lines. It commences with a discussion regarding the Trinity. Then follows the Baptism: with an elaborate picture of the river Jordan. The Temptation; various miracles. The raising of Lazarus is minutely described, in a very poetical manner. The last supper. (But the bread and wine *are not mentioned*). The betrayal to the Jews. The crucifixion.

The fourth book (of similar length) gives further details, with a discussion regarding the possibility of such a death suffered by our Lord. Several apocryphal circumstances are introduced: with a discourse to prove the doctrine of purgatory. The Resurrection. The journey of two disciples to Emmaus is minutely and well described. The doubting of Thomas. The Ascension. The descent of the Holy Spirit. Then follow some apocryphal stories, such as the resurrection of the Lord's mother, " on the third day." Peter appears as the head of the church. A summary of doctrines. The Ten commandments (called Dasa Calpana): the second is as usual omitted. Instructions regarding baptism and prayer: which is to be offered before the crucifix and the Virgin Mary. The teacher concludes with very brief instructions regarding the Eucharist. The disciple returns thanks and is baptized.

It is much to be regretted that any apocryphal doctrine should be admitted into a poem written in so excellent a spirit of piety: but the author has adhered strictly to the line laid down by the church of Rome. In poetical merit this poem may probably stand as high as the *Tembavani*, written in Tamil, by the celebrated Beschi. That distinguished genius has introduced into his compositions some of the elegancies of Latin and Italian literature: but in the *Vedanta Rasayanam*, we have a work of great beauty, which in every page bears marks of the author being a native of India.

This poem has been well edited, and illustrated with a verbal commentary or explanation, as the style in some parts is too much elevated to be generally understood at the present day without such aid. For education is at present in the lowest state among the Telugu people; they being nearly as illiterate as were our ancestors at the period when the invention of printing led to the restoraion of learning. A careful study of the *Vedanta Rasayan* may ultimately produce a desire to emu-

late a poem of merit so distinguished, and will prove that the Telugus possess a christian poet who may rival in talents a George Buchanan, or a Casimir; and who further, like Milton, had the advantage of writing in his native tongue.

VII.—*On the Fossils of the Eastern Portion of the Great Basaltic District of India.—By* John G. Malcolmson, *Esq.*, F. G. S.

CONTENTS.

Introduction.—Objects of the Memoir.
General Sketch of the Physical Features, Hydrography and Geology of the Basaltic and Granitic Districts.
The valley of the Nerbudda, Godavery, Kistnah, and Pennar.
Granite platform between the Kistnah and Godavery.
Iron ore, mines, and manufacture of the steel.
Description of the Sichel Hills, and of the Freshwater Shells.
Country between the Sichel Hills and Nagpoor.
Origin of Minerals in Trap Rocks.
Description of the Lonar Lake and analysis of the water.
Age of the diamond sandstone and argillaceous limestone.
Inferences respecting the Freshwater Fossils.
Other districts in India in which similar Freshwater Shells have been found.
Relative age of the Laterite and Trap.

Introduction.

The principal objects of the following paper are, to submit to the Society an account of a series of fossils discovered in the eastern part of the great basaltic district of India; and to endeavour to arrive at some approximate conclusion respecting the geological era of this basaltic formation, which, extending over more than 200,000 square miles, conceals, breaks up, or alters all the other rocks from beneath which it has forced its way. Of the eruptions to which this rich and romantic country (formerly including several considerable kingdoms) owes its existing form, a late President of this Society remarks*, that the mind is almost lost in the contemplation "of their grandeur;" but "that unfortunately the relative age of the eruptions must remain for the present undetermined, no vestiges of secondary or tertiary formations having been detected within the region." Having therefore, in 1832, collected a series of la-

* See Mr. Murchison's Anniversary Address, Geological Proceedings, vol. i. p. 454.

custrine fossils, probably referable to the tertiary epoch, from a portion of this district extending 140 miles north and south, and having procured others from localities to the north and west of that which furnished my own collection, I am induced to submit the specimens to the Society*. If they should be deemed of sufficient value, I wish a selection to be deposited in the museum, to afford a means of comparison with a duplicate set, which I shall forward to the Asiatic Society of Bengal.†

But it is not alone by supplying some data from which to infer the relative age of the great trap formation, that these specimens are valuable. They will afford the means of connecting the great sandstone formations of the south and north of India, containing the celebrated diamond mines of Parteal (Golcondah), Bangnapilly, and Panna, as well as the limestones and schists associated with them ; and which, from the latitude of Madras to the banks of the Ganges, exhibit the same characters, and are broken up or elevated by granite or trap rocks, in no respect differing in mineralogical characters or geological relations. A few remarks on these formations, and the physical geography of the countries in which they occur, will be a necessary introduction to a more particular account of that portion of the trap district in which the fossils were found, Mr. Calder's sketch not being sufficiently detailed, and the map attached to his memoir containing some errors of material importance.‡

GENERAL SKETCH OF THE PHYSICAL FEATURES, HYDROGRAPHY, &C.

An elevated tract to the north-west of Bundlecund (not included within the range of the Map,) may be considered as the geological connexion between the provinces watered by the southern branches of the Ganges and the Deckan, including all the countries to the south of the Nerbudda. From the north of this plateau, which extends far to the west, a number of great rivers descend, by a series of rapids and falls over sandstone escarpments, into the valley of the Jumna and the Ganges. From the east and south of the same tract, the Mahanuddy river collects a great body of water, and after a comparatively short course through countries little known, but containing the diamond mines of Sumblepoor and extensive trap and gneiss formations, empties

* See Plate drawn, engraved, and described by Mr. James de Carl Sowerby.

† The series of specimens presented by Mr. Malcolmson to the Geological Society have been arranged in the foreign department of the museum.

‡ Asiatic Researches, vol. xviii.

itself into the Bay of Bengal, not far south of the Delta of the Ganges.

The Nerbudda, which flows in an opposite direction, is more interesting in a political and geological point of view; and the extensive countries through which it passes have been more carefully investigated than any other part of the Peninsula. This river takes its rise to the west of Amerkantack, and traversing a country of granite, sandstone, and basalt, abounding in iron and the finest dolomitic marbles, reaches the Indian Ocean through the alluvial plains of Guzerat. At Jabulpoor and in the neighbourhood of Saugur, fossil mammalia, shells, and silicified palms have been recently discovered. Fossil shells have also been found in some of the trap hills, which have broken up the sandstone near the sources of the Taptee. This river is separated from the Nerbudda by a range of basaltic mountains; and having the same direction as the Nerbudda, its whole course appears to be in the basaltic formation. (See N. W. corner of Map).

All the other great rivers of the Peninsula, including the Godavery, Kistnah, Pennar, and Cauvary issue from the western Ghâts, from the summits of which the country slopes gradually to the east, except at the extreme south, where the descent to the plains of the Carnatic is considerable and precipitous.

The Godavery (see Map,) rises in the basaltic region described by Colonel Sykes, (Geol. Trans. vol. IV pt. 2, 1836) and, greatly increased in size, it enters the granitic table land of the Deckan, and flows at the southern foot of the Sichel Mountains into a sandstone and argillaceous limestone country. This district is similar to that of Bundlecund and Malwa; it also contains diamonds, and has been much broken up by erupted rocks. From the north, the Godavery derives large supplies of water from the great rivers rising south of the Nerbudda and the Taptee, in basaltic tracts, the soil of which being retentive of moisture, the water is everywhere near the surface. From the south it receives only the Munjerah river, which, flowing through arid granitic plains, furnishes but a scanty addition of water, except during the rainy season. Through a pass in the gneiss mountain of Papconduh it enters the plains of the Coromandel coast. In this district the sandstone reappears, at an elevation little above that of the sea; but basaltic hills, several hundred feet in height, in which marine fossils have recently been discovered, exist almost within the delta formed by its sediment.

The Kistnah derives its waters from a number of considerable rivers, rising in the basaltic and gneiss summits of the western Ghats, which condense the greater part of the clouds carried by the south-west monsoon from the Indian Ocean. Flowing through the territories of the

southern Mahrattas, a country covered with a rich basaltic soil, and abounding in schistose limestone, sandstone, granitic rocks, and basalt, it enters the granitic platform of the Deckan, the limits of which in this direction are unknown. The limestones and sandstones, however, soon reappear on descending the river, and extend across to the basin of the Pennar, and as far as the ascent to the granitic platform of the Mysore. It is on the banks of the Kistnah that the richest diamond mines occur, and that the sandstones acquire their greatest elevation, amounting to more than 3000 feet ; the river passing through mural precipices of this rock and of the schistose limestones to be presently described. It then enters the plains of the Carnatic, where the same rocks occur, sometimes a little elevated above the level of the sea, at others forming the caps of granite mountains, or broken up by varieties of greenstone and basalt. Thence, passing through a narrow gorge in the gneiss hills of Bezwarrah, it enters the alluvial plains continuous with the delta of the Godavery. Its waters, however, are more loaded with mud than the last-mentioned beautiful river, and the deposit of new land may be seen, by the inspection of a common map, to be proportionably great.

The Pennar is comparatively a small stream, but of much geological interest, the greater part of its waters being derived from the districts in which the diamond sandstones and the argillaceous limestones, on which they rest, are exhibited in their most characteristic forms, and where they are most easily investigated. To describe these strata in detail would be out of place here ; but a few of the leading facts must be stated, that the identity of the formations with those of the fossiliferous district, more immediately the object of this paper, may be rendered manifest. Like all the rivers of Southern India, granite is frequently seen in the bed of the Pennar, more especially in its southern branches, where the passes of Ryachottee lead to the granitic table land of Mysore, having an elevation of 3000 feet above the sea, or 2500 above Cuddapah, the principal town of the Pennar basin. With these exceptions, and the occasional appearance of trap through the stratified rocks, the rest of its course, till it approaches the sea, is over rich plains of black and saline alluvium, derived from the decomposition of basalt and of the stratified rocks so often referred to. From these plains numerous table lands, insulated eminences, and ranges of hills, having for the most part a direction nearly N. E. and S. W., rise abruptly, presenting mural precipices of difficult access, around the base of which the roads often make extensive circuits. The Nulla Mulla hills extending from the Mysore frontier to the basins of the Kistnah and Godavery, and the minor ranges

dependent on them, and having the same composition and direction, are crossed at right angles by the Pennar, which makes its way through them, like the Kistnah, by traversing narrow gorges, with perpendicular sides.

There is not a more remarkable phenomenon in the district watered by the Pennar than the horizontal summits of many of the ranges, and the distinct manner in which the continuity of the strata can be traced from one hill to another, although extensive plains intervene; while, at no great distance, the sandstone which forms the summits of these hills is seen on the same level as the surrounding plains. Numerous instances also occur in which the original continuity of the horizontal summits is easily traced; the strata on the opposite and nearly perpendicular sides of a valley being similar, but having a considerable dip, the beds descend to the general level of the country. A good example of this is seen, in Section 2, Pl. 6., at Chintagoouta and Gundicottah. These anomalies were at first quite inexplicable, nothing appearing in the valleys but a rich alluvium, nor on the summits (which are reached with much difficulty) but a sandstone perfectly horizontal, and divided into huge tables by perpendicular partings, sometimes separated several feet from each other, and filled with broken pieces of the rock. This jointed structure is common to the sandstone, the schistose beds on which it for the most part immediately reposes, and the stratified limestone into which these schists pass insensibly; but the size of the tables so formed, varies from rhombs of a few inches, in the schist and lower part of the sandstone, to enormous masses on the summits of the hills. Nowhere is this structure and the succession of strata, of which it is characteristic, better seen than in the table land in which are situated the celebrated diamond mines of Bangnapilly and others now deserted. From the accompanying plate some idea will be gained of one of these mines.*

The plains at the base of the table land of Bangnapilly consist of a rich black alluvium, containing fragments of basalt, jasper, and the various minerals found in the hills. It rests on a fine, compact, dark blue or nearly black limestone, which contains much argillaceous and siliceous matter. This limestone abounds with springs, and is in some places so cavernous as to afford passage to subterranean streams. Basalt protrudes in a few places near Bangnapilly. On ascending the hill, the limestone becomes more schistose, and is of a paler colour, gradually approaching in its structure and composition to clay slate, but it is far more friable. On the schist a more or less compact sandstone rests

* The plates will be given in our next number.—Ed. Madras Journal.

varying very much in colour, composition, and appearance in different places. Above Bangnapilly it contains the diamond breccia described by Voysey. As far as the shafts which I had an opportunity of observing, enabled me to judge, the breccia is not an interstratified rock, but an intermixture of the common sandstone, in different parts of the same stratum, with larger fragments of older rocks, generally rounded but sometimes angular. It is not, however, the object of this paper to describe the mines and the interesting district in which they occur further than is necessary to exhibit the type of the formation, by the study of which I was enabled to understand more clearly, the less distinct appearances exhibited by the same rocks, where they have been invaded or buried by the great basaltic eruptions of Central India. On the opposite or west side of the valley, the hill is composed of the same argillo-calcareous formation; but, according to Colonel Cullen, " instead of a sandstone cap, it is crested in its whole length with a sharp black ridge of trap rock, formed of loose blocks piled upon each other, the apparent base of which observed a pretty uniform level, nor is the ridge of much depth. Its extreme narrowness, deep black colour, and the total absence of all traces of vegetation, formed a singular contrast to the rest of the hills, which were covered with long dry grass and scattered bushes*." At a small pass some miles further to the west, the road in ascending, passes over first the dark limestone and a narrow belt of schist, then trap, which is again succeeded by limestone, and the latter by schist, nearly to the summit, " which is capped with a rock of a beautiful flesh colour, with specks and shades of a beautiful green, as if connected with its vicinity to the trap, and of so close and fine a texture as to appear homogeneous even with a lens." " The descent of the pass on the opposite side consists of a clay slate nearly to the foot, where the limestone reappears, and these two rocks continued to alternate with each other to the foot of the second Ghât, which, like all the former, was composed of clay slate capped with quartzose sandstone†."

The sandstone exhibits many varieties of grain, colour, and hardness: in some places it is white or red, and can be cut into pillars and slabs of great size and beauty; in others it is soft and friable, and its inferior beds are not unfrequently schistose, so as to be with difficulty distinguished from the subjacent rock, with which it has in one or two places been observed to alternate. Where the sandstone approaches the great granitic tracts to the south and west, it passes into a compact quartzose

* Colonel Cullen, in Transactions of the Literary Society of Madras, January 1837 p. 50. † Ibid.

rock, as is seen on both sides of the Tripatty Valley. This passage is also observed in other places, as near the Cuddapah diamond mines, where the plentiful occurrence of basaltic pebbles shows the neighbourhood of the trap. Besides the diamond conglomerate, consisting of a great variety of minerals, seams of rock crystal occur, and a fine white quartz containing argentiferous galena, which in former times furnished the country with lead. Specular and micaceous magnetic iron ores, but containing much peroxide, and common iron pyrites, occur with the galena. As far as I have observed, the sandstone always rests conformably on the schists, although from its jointed structure it occasionally, when elevated, appears to meet the subjacent rock at a more or less obtuse angle.

The schists on which the sandstone rests, vary very remarkably in colour, being in different places blue, red, green, or pure white, in which they seem to bear some relation to the incumbent sandstone. They are also occasionally flinty or jaspideous. Sometimes they are wanting, the sandstone resting directly on the limestone, of which the schists are evidently merely the upper beds, and into which they pass insensibly, although it seldom happens that considerable effervescence does not occur on examination by tests. It is in many places impossible to say to which portion of the series any particular specimen belongs.

Voysey has classed the schists with the sandstone under the name of "(the clay slate formation;)" I have, however, preferred to designate the deposit "argillaceous limestone," a term used by him in one of his sections as applicable to the limestone, and which well expresses not only the general character of the rock, but that also of the upper schistose beds.

The limestone is a compact rock, but the strata are usually thin, and are often intersected by vertical partings, a circumstance which frequently limits its use in ornamental architecture. Its most common colour is a light blue, passing into black; but it occasionally occurs of a nearly pure white, and affords an admirable material for basso-relievos. On this stone the finest sculptures of the ruined city of Amrawuty are executed, and for delicacy of workmanship they have perhaps never been surpassed. Were it not for the occurrence of small crystals of quartz, the same quarries would furnish an excellent lithographic stone. Near Cuddapah the dark variety is the common building stone, and many fine columns, caryatides, and cisterns are composed of it. The stone is applied to the same objects in the southern Mahratta country, and along the course of the Godavery towards Nagpoor.

To the south and east of Cuddapah, a narrow valley, nearly 150 miles

in length, extends through the limestone, the strata of which are in some places nearly vertical, but form rounded hills. In others they are capped by sandstone, which exhibits mural precipices of much grandeur, and almost or entirely inaccessible. The strata, for the most part, dip to the N. W., resting on the granite of the Carnatic. This rock is penetrated by many dikes of greenstone, which have evidently been instrumental in elevating the stratified rocks to their present singular positions. Little has yet been ascertained regarding the thickness of these strata, which differ much even in the same range of hills. The only minerals they have been ascertained to yield, are varieties of quartz and iron pyrites, the latter of which is so abundant in a few localities, that sulphur is manufactured from it. At Jumulmudagoo I found the limestone interstratified with muriate of soda ; and it is therefore probable, that the salt diffused through the alluvial soil so extensively as to render the water of the Pennar brackish during the hot season, and the inhabitants independent of the sea-coast for a supply of that article, is derived from this source.

On emerging from the gorge in the Nulla Mulla range, the Pennar enters the plains of the Carnatic, and near its mouth flows through low hills of laterite. This deposit rests on the ordinary granite of the Carnatic, with its associated sienites, hornblende schist, quartz rock, and mica slate. It is in a rock composed of a mixture of the last two minerals, that the copper-mines of the Nellore district are situated*. In the same neighbourhood, the sandstone and argillaceous limestones are little elevated above the sea, and are continuous with the same rocks on each side of the Kistnah. They are broken through by insulated basaltic hills, in the neighbourhood of which subterranean sounds and frequent local earthquakes are reported to occur; an assertion I am the more inclined to believe, having myself experienced two slight shocks during a casual visit to the district.

Having briefly described some of the more remarkable phenomena exhibited by the southern portion of the great sandstone and argillaceous limestone formations, it will be unnecessary to enter into any detail when

* The ores are of various kinds, but the richest is a sulphuret, containing, according to Mr. Prinsep, 69 per cent. of the pure metal. The copper also occurs in a slate which Mr. Ouchterlony, of the Madras Engineers, informs me, was considered in Cornwall to be identical with the Killas. If this slate belongs to the "argillaceous limestone" formation, the fact will be of use in determining the relations of that rock to the gneiss, talc slate, and mica schist ; a subject on which no observations of any value have yet been made. The primary rocks of this district contain magnetic iron ore and corundum, both of which occur in the diamond sandstone.

we meet with the same rocks to the north of the Godavery in connexion with the fossil beds discovered in the great basaltic district.

Granite Platform between the Kistnah and Godavery.

(See Map and Section I.)

With regard to the granitic platform of the Deckan, which intervenes between the Kistnah and Godavery, much accurate information is already before the public; it will therefore be necessary only to observe, that it is intersected by numerous greenstone dikes (sometimes of greenstone porphyry), having for the greater part a direction from S. by E. to N. by W., and not very different from that of several of the ranges of basaltic mountains to the north.

These dikes, and the detached masses connected with them, are entirely composed of a crystalline compound of hornblende and felspar, without distinct crystals of augite; and I have never detected olivine in them.* The rock shows a tendency to separate into spheres composed of concentric layers and into irregular prisms; and the same structure in some degree occurs in the granite, sienite, pegmatite, &c. of the whole of the south of India. The greenstone is exceedingly hard and difficult to work, but it takes a most beautiful and durable polish, as in the magnificent mausoleums of Golcondah, the tombs of Hyder Ali and Tippoo Sultan, at Seringapatam, and in many of the sculptures of the Carnatic pagodas†. Where these dikes rise into hills, the summits only are composed of the compact greenstone, which graduates below into the granite of the surrounding country. Many of the veins of basalt in the passes of the Mysore and Neilgherry mountains differ from these, in possessing the structure of the compact basalt of Bombay and other places in the trap countries, and in branching into narrow veins, (often not an inch thick,) which traverse the granite without mixing with it; while the ordinary greenstone dikes of the Deckan are almost always accompanied by separate nodules, of greater or less dimensions, insulated in the granitic mass, the component parts of which appeared to me to be there, in most cases, arranged in larger crystals, and to be more subject to decay, than in other places. I could not resist the inference, that, at the time of the formation of these dikes, the granite was in a state approaching to fluidity; although, as some of the narrow veins can be traced for many miles through the granite, they do not appear to have been formed at the same time.

* "In a specimen in the Geological Society's Collection, taken by Dr. Voysey from a '*greenstone dike*' passing through granite at Guntoor, south of the Kistnah river, olivine s diffused amongst the other constituents of the rock." June 25th, 1839.

† It is familiarly known in India as "black granite."

Several small basaltic hills are insulated in the granitic platform in the line of route between Hyderabad and Nirmul, and they are based on decaying granite. Their flat summits and steep sides correspond with the hills of the great trap district; and the general line of bearing, of the broken ranges of which they appear to form a part, does not differ much from that of the basaltic mountains to the north, or from the greenstone dikes; but many hills are scattered over the plains to the east and west, and cross this line of route in every direction. The lower part of the hills is composed of thin tables or laminæ of a sonorous trap, and the upper of globular concentric basalt; the external layers of which are extremely friable, generally grayish, or soft and soapy to the feel, and are of a greenish tint, except where the stone is much loaded with ferruginous grains of a reddish brown colour. In some places the metallic matter has the appearance of having been partially smelted, and is of a fine red hue.

The nuclei of the " concentric basalt," which are exceedingly tough, and resist decomposition powerfully, are of a deep black colour, and contain large crystals of olivine, and small kernels of calcedony. The first of these minerals is not found in the soft external coats, yet it is so closely united with the substance of the rock as not to admit of a doubt of its being of contemporaneous formation, and not, as supposed by Berzelius*, a fragment of a pre-existing stone enveloped in the liquid matter. Small, but very characteristic specimens of calcedony are of more frequent occurrence in the softer portions of the rock, especially between the concentric nodules; but they are intimately mixed with their substance. It is remarkable, that I detached no calcareous minerals in similar situations in these hills, although the rock is so impregnated with lime as to have led to an extensive deposit of calc-tuff (Kunkur), at present forming along its base, and projecting sometimes half a foot from between the partings of the basaltic tables.—" The presence of olivine, the soft wacké in which the globular basalt is imbedded, the less crystalline structure, the passage into a porous amygdaloid, containing calcedonies, zeolites, &c., and the granite in the neighbourhood of all the smaller masses differing little from that at a distance," may perhaps be sufficient to distinguish these insulated basaltic hills from the greenstone†.

On approaching the Godavery, the granite in some degree changes its appearance, containing large and beautiful crystals of red felspar, occasionally imbedded in veins of transparent quartz, clouded with spots

* Edinburgh Journal of Science, January 1839.

† Journal of the Asiatic Society of Bengal, February 1836, p. 105.

and wavy lines of a turbid milky colour. Greenstone dikes are there more common. The river flows over granite, which is intersected by several dikes of greenstone, running more in a north and south direction than those above referred to, and having many minute white crystals diffused through their substance. The dikes project from 8 to 10 feet above the granite, and are divided into rhomboidal masses by fissures, in which lime is deposited. The bed of the river is covered by numerous fragments of calcedonies, zeolites, and other minerals found in volcanic rocks; and they have been cemented into a more or less solid calcareous conglomerate. The banks are composed of a black basaltic soil, from the lower part of which, where it rests on the granite, as well as from the divisions between the several layers of alluvium, thin slabs of a clayey calc-tuff (Kunkur) project, and are connected above with portions formed round the roots of plants, and below with other layers spread out between the different strata of alluvial earth*. These appearances sufficiently indicate the neighbourhood of the basaltic range of mountains, distinguished in Arrowsmith's large map as the Sichel or Shesha hills, but which are locally known by the name of the Nirmul range, from the large town situated six miles from the difficult pass leading up the steep escarpment presented by their southern face. None of the stratified primary rocks are seen at the foot of these hills in the line of the section; but twenty miles to the east of Nirmul, and a few miles south of the mountains, hornblende slate occurs, resting on granite and quartz rock.

Iron Ore, Mines, and Manufacture of the Steel.—The magnetic iron ore, employed for ages in the manufacture of the Damask steel used by the Persians for sword-blades, is obtained from this schist. The mines I examined, are those of Deemdoortee, but the ore is extensively distributed. The minute grains or scales of iron are diffused in a sandstone-looking gneiss or micaceous schist, passing by insensible degrees into hornblende slate, and sometimes containing amorphous masses of quartz. The strata are much broken up and elevated, so that the dip and direction are in no two places the same, and bear no relation to the mountains to the north.

Manufacture, &c.—The mines are mere holes dug through the thin granitic soil, and the ore is detached without difficulty by small iron crow-bars. It is then collected and broken on projecting masses of

* Further details on this part of the route will be found in some notes explanatory of a collection of specimens presented to the Asiatic Society of Bengal, and published in the Journal of that Institution for February, 1836.

granite or quartz by means of a conical-shaped fragment of compact greenstone; but when too hard to yield to this simple instrument, it is previously roasted. The sand thus procured is washed in shelving depressions dug near a tank, and the heavier parts, separated by this process, are exactly similar to Voysey's specimens of the iron-sand used in the manufacture of Damascus steel at Kona-Sumoondrum, in the same neighbourhood; but from his published papers, it does not appear that he had seen the rock from which they were derived. In other respects, all the information I could procure, accurately corresponds with that given in his interesting paper.* The ore is then smelted with charcoal in small furnaces, which have often been described. I did not see any flux used; but, although I watched the whole process, from the digging of the ore till it was formed into bars, I will not assert that none was employed. The iron has the remarkable property of being obtained at once in a perfectly tough and malleable state, requiring none of the complicated processes to which English iron must be subjected, previous to its being brought into that state. Mr. Wilkinson, who has investigated the history of Indian steels with much scientific and practical skill, did me the favour to submit to experiment a specimen of this iron as it came from the furnace. He found it extremely good and tough, and considered it superior to any English iron, and even to the best descriptions of Swedish. The Persian merchants, who frequent the iron-furnaces of Kona-Sumoondrum, are aware of the superiority of this iron, and informed Dr. Voysey, that in Persia they had in vain endeavoured to imitate the steel formed from it; a failure which could be ascribed only to the difference of the materials used, as the whole process of the conversion into steel was conducted under their own superintendence. It is also probable, that there are few places in India where an ore of equal value is so easily procured; otherwise its distant inland situation, in a difficult and unsettled country, would not have retained a reputation for so many ages. In the manufacture of the best steel three-fifths of this iron is used; the other two-fifths being obtained from the Indoor district, where the ore appears to be a peroxide. It is evident, that if the beautiful water of the Damascus blades is derived from the crystallization of the steel, the use of two very different varieties of iron, one of which has been ascertained to be of such admirable quality, must have an important influence on the appearance and quality of the manufacture.

As these mines afford a boundless supply of ore easily wrought, and

* Journal of the Asiatic Society of Bengal, vol. i., p. 245.

are situated in the neighbourhood of vast forests, and near a river navigable for boats during part of the year, it is probable, that at no distant period, when the native government has undergone some amelioration, iron may become an important article of commerce. On this account, and because, although much has been written regarding Indian steel, nothing has yet been brought prominently forward regarding the finer kinds of iron ore with which that country abounds, I will make a few additional observations regarding them.

Dr. Heyne has accurately described the manufacture of iron in the Carnatic, to the south of the Pennar river, and he states that it is, when first smelted, extremely brittle, requiring several operations to bring it into a malleable state. I possess specimens of two varieties of ore used in the district in which he observed the processes, and where I have myself seen them carried on. The one, an iron sand, collected in the beds of rivers, consists of the protoxide, mixed with much of the peroxide; the other, a red schist, is almost entirely composed of red oxide, but in the centre of the mass it affects the magnet. Not far from where this rock occurs, I collected specimens of hornblende schist, leaving little doubt as to the ores being of the same nature, the former having become altered *in situ*, in the same manner as some of the superficial strata at Deemdoortee are seen to do. I therefore conclude, that the superior quality of the Nirmul iron depends on the ore being a comparatively pure protoxide. It certainly is not dependent on the nature of the fuel, which is much the same in both places*. Captain Herbert, indeed, long ago suggested, that the superiority of the Gwalior iron over that principally worked in the Himalayahs, depended on the former being a magnetic ore, like that of Sweden; but the first accurate information on the subject was communicated by Dr. Royle to Mr. De La Beche, who states†, on the authority of that gentleman, that magnetic iron ore is extensively diffused in hornblende slate in the central range of mountains in India, and that it also occurs in the Himalayahs. This geological position corresponds with that of the Nirmul ore; but the latter does not bear any resemblance, except in its peculiar lustre, to the Menaccanite of Cornwall, to which it is compared by Mr. De La Beche;

* Iron, which has been ascertained to be superior, for many purposes, to the best German iron, has been recently imported from the western coast of India; but the mines from which it was obtained have not been examined. Captain Jervis, of the Bombay Engineers, however, informs me, that ores, powerfully affecting the magnet, exist in great quantity at Taygoor, a village of the Koncan, not far from the port from which the iron in question was procured.

† Manual of Geology, 3rd Edit., p. 435.

nor could I detect any titanium in it. With regard to the geological relations of the magnetic iron ore, it is also necessary to observe, that in India it is not confined to the hornblende schist, but is found extensively distributed in the granite and gneiss of the Carnatic and Mysore, in quartz rock near the iron works of Porto Novo; and, as has already been observed, associated with galena in the diamond sandstone of Cuddapah. The discovery of a mineral, so generally confined to the primary rocks, in the great sandstone formation, affords an additional argument in favour of the opinion of those, who consider this rock and the subjacent schists, as equivalents to the older European sedimentary formations, rather than to those of the supermedial order.

Description of the Sichel Hills, and of the Freshwater Shells.

Returning to the line of route, the granite, on approaching to the Sichel hills, becomes softer and decomposes rapidly; and the soil gradually changes to the well-known black basaltic mould, known in India by the name of "cotton ground," and, as usual, it is mixed with calcedonies, zeolites, &c. Amongst these minerals were some fragments of a red colour, and considerable specific gravity, though full of irregular cavities, and so like the slag of an iron furnace, that I considered them to have had that origin, till I discovered a considerable mass of a similar nature protruding from the granite and black soil by which it was covered. Along with these fragments were others of a semivitrified matter, containing small white crystals of felspar, and hardly to be distinguished from a piece of granite fused by Dr. Voysey in the steel furnaces of the neighbouring district. The granite constitutes the surface rock a little further, gradually passing into a black compact basalt, intermixed with many white spots, apparently of felspar. The trap then becomes softer, forming small hills of a cellular amygdaloid, abounding in cavities lined with green earth, and many of them filled with calcedonies, zeolites, quartz crystals, and, more rarely, calcareous spar, of the same kind as those, so remarkable for their beauty, in the portion of this formation described by Colonel Sykes (Geological Transactions, vol. 4, p. 422*). The crystals also occur in seams, or are diffused through the trap; and in both cases

* A beautiful variety of chabasie, having the angles replaced by triangular or pentagonal faces supporting a rhomboidal surface, of which beautiful specimens abound in certain localities of the western portion of the formation, has not been met with in this neighbourhood; but, like some other minerals of the basaltic district, it is not generally diffused in the rocks where it is most abundant; so that I have travelled for several hundred miles without meeting with it.

are intimately mixed with its substance. In the bed of a torrent between two of these hillocks, I met with some soft, clayey, schistose fragments, and others of a siliceous character, and of a black bituminous appearance in the centre, containing very perfect specimens of the *Paludina Deccanensis* (Pl. fig. 20,) and fragments of other shells to be hereafter described. Those which I examined were converted into calcedony. A laborious research on the hill failed to discover them *in situ*; but about half-way up the escarpment of the principal mountain, which is very steep, and composed of concentric nodular basalt, imbedded in a soft greenish wacké, a narrow band of a singular quartz rock projected about two feet from the surface. It was remarkably scabrous, of various shades of white and red, and had cavities on its surface covered with fine silky crystals. It had every appearance of having been forced into its present situation, when the basalt covered and partially melted the bed to which it belonged. Many fragments of this rock were found below with the shells; and it was again met with, together with the same and other fossils imbedded in basalt, near Hutnoor. The specific gravity of this rock is 2·473, and some of the specimens effervesced feebly in acids, a portion of lime being dissolved; circumstances in which it corresponds with a similar formation found by Voysey, associated with shells, probably of the same kind, at Medcondah (south of the Godavery), an insulated basaltic hill resting on granite, to which I shall have occasion again to refer. The highest summit of the hills, above the locality of the fossils, is conical, but it is capped by a perfectly horizontal stratified rock, the nature of which I could not determine. It is most probably tabular basalt, although that rock is seldom found in similar situations.

Such are the appearances presented on ascending the difficult pass leading up the steep escarpment of the Sichel hills, which form the southern boundary of the eastern portion of the great trap formation of Central India. The hills extend from the junction of the Wurdah and Godavery rivers (the basins of which they separate), till they are lost in the gradual rise of the country to the west, near Lonar (lat. 20°, long. 76°, 30′), in the province of Aurungabad. Their direction is W. N. W., and, as far as can at present be inferred, they seem to be continuous to the east with numerous ranges of basaltic, sandstone, and granitic hills, extending to the Eastern Ghâts, at the lower parts of the course of the Godavery. The extreme breadth of the range, from the foot of the Nirmul pass to the town of Yedlabad, (nearly on a level with the plain country of Berar,) is about 40 miles; but several smaller hills having for the greater part the same direction, are intimately connected

with them to the north, as far as the Wurdah river, which has an elevation of little more than 600 feet above the sea. The Sichel hills are arranged in terraces, with steep sides having projecting spurs, and their summits rise occasionally into conical elevations with rounded or flat tops. They inclose narrow valleys abounding in streams, or support table-lands covered with black soil strewed with trap boulders, and having water everywhere near the surface. A thick wood and grass jungle, composed of very different plants from those common on the granite hills, cover the whole tract, with the exception of the flat summits and some of the terraces, and render it unhealthy for the greater part of the year. The basalt of which they are composed, is generally globular, the spheroids being sometimes of great size ; but in many of the water-courses, even of the elevated table-lands, it has a stratified appearance. Small basaltic columns are also met with on the crests of some of the spurs and higher ridges ; and where they occur, no fossils and few minerals are found. Granite not only forms the base of the hills at Nirmul to the south, and Yedlabad to the north, but part of the mountains themselves, the basalt being seen to rest on decomposing granite about the centre of the range, in a deep ravine, through which the Koorm river passes ; it also again appears high in the table-land to the north of that river, and in one of the terraces of the northern descent, where the most extensive fossil beds were found. Further detail is unnecessary, as Dr. Voysey's admirable description of the Gawilghur mountains, forming the northern boundary of the great and fertile valley of Berar, as these hills do its southern limits, applies equally well to both ranges*.

The fossils were first discovered *in situ*, near Munoor, in the basaltic table-land north of the Koorm river ; and were subsequently found in the descent of the hills towards Hutnoor, and in different parts of the Mucklegundy pass, leading into the Berar valley. They consist of numerous gyrogonites ; two species of Cypris ; two, or perhaps three, species of Unio ; and many individuals referable to the genera Paludina, Physa, and Limnea (see Pl.). The rock in which they occur, varies in different places. Some of the finest specimens were procured from a red chert with scabrous furface, having silicified shells distributed throughout its substance, or projecting from its surface. The chert is deeply imbedded in the nodular basalt, from which it projects in some places several feet. The finest specimens of Unio occur in a beautiful gray chert, imbedded in the basalt, or resting immediately on it, the under surface being plain and smooth, while the

* Asiatic Researches, vol. xviii.

upper is rough, from portions of the large shells which project from it. On breaking up one of these masses, it was found to contain entire Unios, many of them having the valves connected and closed, or partially open; the interior being filled with the same chert, spotted with fragments of shells, minute univalves, and fine specimens of the two species of Cypris, which occur so abundantly. Some parts of the rock exhibit a mixture of sand, clay, and fragments of shells, of very moderate hardness; but the greater portion consists of chert, the materials of which are occasionally arranged in a beautiful, light blue, enamel-like substance, around irregular cavities containing crystals of purple quartz. Some portions also exhibit a minute vesicular structure; and the whole appearance of this beautiful rock forcibly impresses the mind with the conviction, that it owes its present appearance to the action of the great basaltic eruption, which has enveloped it and the organic remains. The greater number of the shells are converted into chert, but a few retain their original structure; and in some instances the calcareous matter has been converted into crystals of calcareous spar. Many internal casts of entire shells are found in the substance of the rock, to which they are united at a few points only, a greater or less space being left unoccupied; in others, the entire shell is converted into siliceous matter, retaining the appearance even of the ligaments unaltered; and fortunately, in a few cases, the hinge and teeth are excellently preserved.

Numerous fragments of shelly rock, differing much in appearance, lay scattered about over the table-land; consisting partly of a fine blood-red chert, like that above described, and containing the same shells. The gray chert was more sparingly distributed, and the Unios did not occur in the other fragments. Some of them, composed of a tough white clayey stone, so soft as to soil the fingers, contained Physæ, Paludinæ, and Limneæ, mostly converted into calcedony, but others also retained their original structure, and effervesced with acids. Portions of charred vegetable matter, resembling small fragments of grasses and reeds, occurred in these and the harder cherts. Other specimens are composed of a greenish blue crystalline mass, resembling an ore of copper, (but it is of low specific gravity, and contains no trace of that metal,) and the shells contained in them are converted into the most beautiful crystalline quartz, retaining the form of every convolution of the Physæ and Paludinæ. The cells of this stone are often coated with fine silky crystals. Masses of a hard coarse chert, consist almost entirely of Gyrogonites, but contain many of the same Physæ and Paludinæ. This rock appears to have formed beds of about half a foot in thickness; but

it was not discovered *in situ.* A stratified rock was however found in the neighbourhood, resembling some specimens of the argillaceous limestone of the diamond districts, but consisting of a compact whitish chert, which contained Paludinæ, and the finest specimens of Gyrogonites (Plate, fig. 1). Night prevented the connexions of this rock from being determined: the strata were, however, ascertained to be of considerable extent, and to be much buried in the soil; there were also numerous fragments of siliceous rock, partly converted into a black bituminous flint, or a coarse quartzose rock, partially altered into calcedony, by which most of the shells were also replaced.

The masses of red chert protruding from the basalt contained, besides the Testacea, small portions of silicified wood, and what I consider to be the fragment of a bone, and of the tooth of a mammiferous animal. The specimens, however, are too imperfect to admit of any certainty as to what they really are; but it is not unlikely that such remains should occur, and I therefore do not suppress what may lead to a more successful inquiry

On descending towards Hutnoor, granite, presenting a concentric, ligniform surface, from the unequal decomposition of the quartz and felspar, occurs at a short distance from the fossils*. With this exception, the basalt continues of the same character as before, and fragments of red or deep black chert, containing Paludinæ, are found in the beds of torrents; and at Hutnoor they occur in the trap. There is much calcareous matter mixed with the soil, or collected in nodules, and it appears to be derived from the lime contained in the basalt, or between its laminæ. On the pioneers attached to our camp penetrating, at Elchoda, through some strata of tabular basalt to obtain water for the troops, seams of a pure white, pulverulent lime were found between the layers†. At Hutnoor fragments of a compact blue limestone, not to be distinguished from that of the diamond districts, were collected; and the rock to which they belonged, was found in the descent from the first of the three principal terraces by which the road leads to the northern base of the hills. The strata were much inclined and broken, but the forest was so thick, that I could not trace them for any distance. After descending to the second terrace, the surface rock suddenly changes to a white, horizontally-stratified limestone, almost entirely composed of large bivalve shells, the edges of which decomposing more slowly than

* A similar appearance has been observed at the foot of the Nirmul pass, at the iron mines of Deemdoortee, and in Bundlecund.

† The same was observed in Bundlecund by Captain Franklin. (Asiatic Researches, vol. xviii.)

the cement, the natives have applied to it a name signifying impressions made in clay by the feet of sheep. The thickness of the bed in one place, where it is intersected by a torrent, is 12 feet, and it rests directly on red granite A great spur, from the upper part of the mountain, extends across the terrace, rising precipitously above the fossiliferous limestone, a few hundred yards from the spot where it rests on granite; and has buried the continuation of the stratum under an accumulation of basaltic *débris*. Where the limestone becomes concealed in the basalt, a friable, gray, cellular mass, resembling ashes, occurs, apparently imbedded in both these rocks. The fossils are composed of granular limestone, the matrix consisting of calcareous matter mixed with the ash-like substance, and small fragments of granite. Some of the shells are of great size, but they are ill preserved, and I found only one specimen with the valves united. These shells, I erroneously considered to be marine (principally from the appearance of those represented in Plate, fig. 4 to 8, and some of the large flattened specimens). Mr. Lonsdale, however, who had the kindness to examine some of them, considered their general character to be that of fresh-water species. I had previously detected, in a fragment of a compact argillo-calcareous stone found at the bottom of the little cliff where the granite is seen to underlie the fossils, a number of very perfect Melaniæ; I therefore re-examined the different specimens, and detected in them fragments of the same kind as those in the limestone; and Mr. Sowerby has since been able to extract from the latter, specimens sufficiently distinct to be identified with the *Unio Deccanensis* (Plate fig. 4 to 10), found in the chert at Munnoor, and another species (*Unio ? tumida*, fig. 11 and 12,) not yet discovered elsewhere. No other fossils were found in this locality.

When it is considered, that the accumulation of freshwater shells occurs on the precipitous descent of a mountain range, ascended with much difficulty by travellers, it will be evident that the aspect of the country has been entirely altered since these animals lived.

COUNTRY BETWEEN THE SICHEL HILLS AND NAGPOOR.

Towards the foot of the pass, the rock changes from the nodular basalt to amygdaloid; and near its junction with the granite, masses of greenstone porphyry, with large crystals of felspar, occur. The granite then reappears, protruding in rounded masses through the soil of the level country around Yedlabad. The bed of a stream near that town is strewed with fragments of blue limestone and schist, resembling those of

the basins of the Pennar and Kistnah ; and higher up the stream, a fine white quartzose sandstone, having a few imbedded fragments of quartz, is found *in situ.* It dips at a slight angle to the south-west*. The surrounding country is covered by a deep basaltic soil, so that the rock on which it rests could not be discovered ; but the argillaceous limestone, passing, in its upper strata, into a greenish or red schist, is traversed by a stream a few miles to the north. Short ranges of trap hills, some of them at nearly right angles to the Sichel mountains, occur to the north-east ; and beyond them, an extensive tract of sandstone has been traced for a great distance along the Wurdah.

At Zynad, argillaceous limestone appears on the surface for several miles, and agrees in every particular with the compact marbles of the diamond districts of the Pennar and Kistnah. The strata sometimes dip at an angle of 40 degrees, but they are in general nearly horizontal, the edges of the layers being disposed in steps on the slopes of gently-rising grounds. Rock crystal and calcareous spar are distributed in thin seams between the strata, as well as through the substance of the rock ; and along the vertical partings of the strata, there are rows of circular cavities, which are generally empty, but are sometimes filled with calcareous concretions. In a few instances, these hollows occur out of the line of fissure, and entirely penetrate the stratum, being connected below with horizontal channels of the same kind. On the surface, calc-tuff (Kunkur) is very abundant, often adhering to the strata, or investing fragments of the rock.

The same appearances are seen near the diamond mines of Chinoor on the Pennar, where the strata are much disturbed, and basaltic pebbles cover the banks. The only explanation which can be offered of the phenomena in both those distant localities is, that the extrication of gaseous fluids and water from below, had taken place in the lines of fissure, and had dissolved a portion of the limestone, which was again deposited in the great accumulation of tuff and conglomerate so remarkable in these places. That they at all indicate the " argillaceous limestone" to be of freshwater origin, could never be imagined by any who had seen the rock in question, which, wherever it occurs in the south of India, is entirely devoid of fossils†. This supposition is confirmed by the pheno-

* Minute undulations, resembling those formed by the ripple of running water, were observed on this sandstone, in a seam not quite parallel to the line of stratification.

† This assertion may, in the progress of knowledge, be found to be erroneous ; but having carefully looked for fossils during extensive journeys through districts principally composed of this rock, I doubt whether such will be the case. Fossil plants have been reported to be found near Gundycottah ; but these I ascertained to be mere dentritic markings on the surface of the strata.

mena exhibited at the hot-springs of Urjunah, which rise in the same rock, and where bubbles of carbonic acid are extricated through round holes in the mud covering the bottom of the rivulet, the water of which, being loaded with lime, a calcareous tuff is rapidly deposited.

A gentle elevation, extending three miles to the east of the village of Zynad, is composed of this limestone, and it rises very gradually towards a small conical summit, composed of coarse vesicular basalt, which has broken through and covered the limestone. A portion of this rock appears to have been displaced in a singular manner. A wall of perfectly vertical stratification, about 3 feet thick, projects nearly as much from the general surface, and consists internally of the same limestone, as that which it appears to cut at right angles, while externally it is singularly irregular and altered, being converted into a beautifully crystalline limestone, with quartz minerals.

To the north of this place, as far as the Payne-Gunga river, the country is flat, covered with basaltic soil or rock connected with insulated trap hills, and intermixed with jaspers, resembling those so common near Bangnapilly, and perhaps derived from the argillo-calcareous schists occasionally seen in the water-courses. The pebbles of the Payne-Gunga consist mostly of calcedonies of a reddish colour, and of argillaceous limestone, and they are in many places consolidated into a conglomerate by the calcareous matter with which all the waters of the district abound. In a layer of this conglomerate, projecting from the alluvial soil of which the bank is composed, numerous recent shells are imbedded. The limestone, and its incumbent schists, are seen north of the river, and they abound in springs and streams loaded with lime, which is deposited as calcareous tuff in the water-courses. Masses of the same substance, several feet in height, project from fissures in the rock, or compose conical eminences of white "Kunkur," which are scattered over the black basaltic plains.

Proceeding a little further towards the Pindee hills, in which the principal of these streams takes its rise, sandstone appears on the south bank of a ravine; and on the opposite side, at a lower level, the "argillaceous limestone" so often mentioned, has been raised by some violent forces into irregular gothic arches, overlaid by partially broken but horizontal strata. The spaces within the arches are filled with fragments of the same rock forced from below. Hot springs, having a temperature of 87°, rise through the limestone, and globules of gas escape from round holes in the *débris* and mud covering the bottom of the ravine. On endeavouring to collect a quantity of the gas, there were found to be considerable and irregular intervals between each jet of air.

A recent calcareous sandstone is formed in the bed of the stream, by the *débris* derived from the quartzose sandstone of the southern bank being agglutinated by the carbonate of lime of the springs.

A range of low hills having rounded summits, with conical elevations projecting from their sides, runs in a north-west direction, three quarters of a mile from the hot springs. The cap of these hills, where the Pindee Ghàt passes over them, consists of the argillaceous limestone, and the large slabs of which it is composed, are fissured in various directions, slightly convex upwards; and when taken in the mass, they have an anticlinal dip. On the summit, the strata are horizontal and in several places are remarkably altered, the argillaceous and siliceous ingredients having arranged themselves into a black chert, and a mixture of calcareous matter with streaks of a white or pale blue enamel resembling calcedony. The central parts of these bands are composed of minute quartz crystals; and irregular drusy cavities, coated with amethystine quartz, occur in the blackened flinty portions. There cannot be a clearer indication of the action of heat on a rock of a mixed character than this, even when seen in hand specimens. The whole of the base of the hill is composed of the usual black concentric basalt, the nuclei of which are exceedingly hard and contain much olivine; and to its intrusion the alteration of the limestone, with its separation from the strata below, is, without doubt, to be ascribed.

Many hills composed of concentric basalt are scattered over the neighbouring country, in insulated masses or long ranges rising in terraces, and having flattened summits. The sides of the hills between the terraces are steep, and their outline is well defined; the rock also is black and devoid of vegetation. The terraces occur at very different levels in different hills, rising from the same plain; and their whole appearance indicates that their remarkable form is due to the circumstances which attended their elevation; and that they have not been subjected to any extensive denudation.

About five miles north of the hot springs of Urjunah and four miles south of those of Kair, sandstone caps a gently rising ground, covered with basaltic soil. Near the last-mentioned town, many hot springs rise in the argillaceous limestone, which has been remarkably broken up and altered by the globular basalt protruding through it in different places, in masses several of which are only a few yards in circumference. The limestone is, for the most part, nearly horizontal, but it is occasionally more or less inclined, and, as is usual with this formation, it has no regular direction or line of bearing. In a deep well near the village, the water of which is of the usual temperature, the limestone is unaltered;

but above the principal hot spring, some of the most remarkable effects of igneous action in changing a stratified rock, are exhibited. The principal part of the small hill is a whitish limestone, the stratification of which is obliterated, and the rock projects in irregular masses full of cavities passing deep into the mass of limestone, which is partly crystalline, and in many places mixed or coated with jasper and quartz crystals. Much calcareous tuff (" Kunkur") is associated with these altered rocks, and it fills up many of the cavities ; it is also found in the divisions of the nodular basalt, and masses of it, scattered over the surrounding country, are the only remains of springs which have been long closed up. Some portions of the rock had the appearance, on the surface, of a semifused brick, and had assumed something of a regular arrangement, while the centre was composed of the limestone little altered. Large masses of porous scoria also lay about.

The principal springs issue at the foot of the rising ground, where the rock is most remarkably altered. Their temperature (87°) was the same as that of Urjunah, on the other side of the Pindee hills, and it did not vary during the hot and cold months of 1831 and 1833. The water of this and many other springs is said to be equally copious at all seasons, covering the neighbouring country with the richest vegetation, when all beyond is a black and parched waste. On issuing from the rock, the water is sensibly acid, and in one spring, carbonic gas escapes with the water. It is remarkably agreeable to the taste, and sparkles in the glass, as well as where the stream passes over rapids. It contains a little muriate of soda, a minute quantity of sulphates, and much carbonate of lime in solution, which is deposited on boiling, and in the bed of the rivulet, where it has formed considerable masses of rock chiefly composed of the petrified vegetation of the banks. So quickly is this deposit formed near some little falls, that shells appear to be imprisoned and entombed while adhering to the face of the rock ; and tufts of grass are encrusted with sediment while their roots are still alive. If any doubt remained as to the nature of the nodular limestone, known in India by the name of " Kunkur," it would be removed by the sight here exhibited of all gradations of this substance actually forming, and varying from pulverulent lime to a crystalline rock. The water is probably derived from a great depth, the springs having, as already stated, the same temperature as those of Urjunah, and not being materially diminished by the failure of the annual rains.

Sandstone forms the surface rock in different directions over the surrounding country, but I had an opportunity of examining it carefully only at Won, eight miles north of Kair, its junction with the limestone

being concealed by basaltic soil, mixed with calcedonies, fragments of that rock, schist, and of a coarse puddingstone, which I did not find *in situ*. The hill of Won is composed of sandstone, dipping in all directions from the apex, and varying in colour from white to red and yellow. It contains also ferruginous grains or scales, either in seams or disseminated through its substance. In a fragment of this kind much resembling the cement of the Bangnapilly diamond breccia, a fossil was discovered having a compact structure and deep black colour, and it is probably a portion of a hollow, compressed vegetable, the centre of which is filled with the sandstone. It is the only instance that has come to my knowledge of a fossil being found in the sandstone of Southern India; and as the rock corresponds in geological position and mineralogical characters with the diamond sandstone, the fact is of considerable interest, even if the formations were not found to be continuous, as will be stated hereafter. The specimen is deposited in the Museum of the Asiatic Society of Bengal.

Sandstone, argillaceous limestone, and schist constitute the building-stones of the surrounding country, which is much buried under basalt, and a black alluvial soil containing calcedonies, jaspers, &c. A few miles south of Chicknee,* (where the fossils were again met with,) the red schist found above the limestone south of the Urjunah hot-springs and in various places of the diamond districts of the south, reappears, intermixed with protruding masses of basalt, which have altered it in the most singular manner,—the lime of which it is in part composed, being converted into a fine crystalline mineral, in which the red clay is enveloped or diffused, giving the rock and even hand specimens a very striking appearance. Near Chicknee, the schist rises slightly towards a basaltic ridge, in which the fossiliferous chert is likewise imbedded. The schist is divided into minute rhombs by vertical partings, in which veins of calcareous spar from an eighth to half an inch thick have been formed, and give it a beautiful, reticulated appearance. Lime is found in the schist, and portions of the red clay are enveloped in the crystalline limestone, which contains no magnesia.

The fossils occur on the surface, or are imbedded in nodular basalt over several miles, being found in blocks of indurated clay, chert, and flinty slate. The appearance of the indurated clay is the same as in some of the specimens from the Sichel Hills, but the clay is harder, full of cavities, and in some cases passes into perfect chert, or has waved lines of quartz or opalized matter diffused through the substance of the mass.

* Fossils were first found at Chicknee by Mr. W. Geddes, May, 1829.

Many Physæ, Paludinæ, and a few Limneæ of the same species as those already noticed, are found in this indurated clay or imperfect chert. Some of them are entirely converted into calcedony; others have the lime replaced by quartz, which is finely crystallized and covers the surface of the convolutions; or the columella only is preserved, passing across an empty cast of the shell. In some cases, however, the structure of the fossil is unaltered, and it effervesces in acids. Flinty slate without organic remains occurs in the neighbourhood of those amorphous masses, and many fragments of the same kind containing large compressed bivalves are scattered about. In one block of this kind, portions of palm wood mineralized by black flint, intersected by fine veins of a light blue opal, (of the same kind as occurs in some of the specimens of fossil wood from Antigua, lately presented to the Society by Mr. Stokes,) was found associated with compressed very thick bivalve shells, probably referable to the same species as those of Munnoor.

Every appearance presented by these rocks indicates the action of the semifluid basalt on the beds of mud and sand, probably derived from the neighbouring sandstones and schists, in which the shells previously existed.

At Hingan-ghàt*, a few miles further to the north, considerable fragments of silicified palms and other plants were found in a black chert lying on the basalt, and similar masses, but without fossils, were imbedded in it. I met with no organic remains to the north of this town, the whole country as far as the city of Nagpoor being covered with a rich black soil, from which insulated basaltic hills with flattened summits rise abruptly.

Of these hills the most remarkable is that of Seetabuldee, which is based on decomposing gneiss and mica slate. To Dr. Voysey's descrip-

* In examining with the microscope sections of some of the silicified wood from the district described, a specimen from the chert of Hingan-ghàt appeared to me to be bone, and Mr. Owen, who has had the kindness to examine it, has ascertained it to belong to a mammiferous animal. He has favoured me with the following note on this important fossil:

"A section of this fossil was prepared sufficiently thin to allow of its being examined by transmitted light under a high magnifying power, when it was found to possess the structure characteristic of bone. Sections of 'Haversian canals,' with their concentric lines, were everywhere present, interspersed with numerous Purkingian cells or corpuscles: the size and disposition of these characteristic parts of the osseous structure agreed with those of the bones of the Mammalia. It was highly satisfactory to find the microscopic test as available in demonstrating the presence of bone, when ordinary characters and the unassisted eye would have left the matter doubtful, as it is in reference to the determination of the teeth."—July, 1839.

tion* I have nothing to add; but as it has been inferred†, that the "flattened summits and long flat outline" of the low ranges connected with this celebrated hill, and forming the eastern part of the great trap district, are composed of basalt having the same stratified appearance as that of other parts of the formation, it is necessary to mention, that they are formed of globular basalt such as has been already described, or of basaltic columns of very regular forms, which diverge from the centre of the hill and incline outwards at an angle of 45° with the horizon, or form a figured pavement on the flat summits.

Origin of Minerals in Trap Rocks.

The lower part of the hill of Seetabuldee itself exhibits a tendency to columnar structure, caused by horizontal and vertical partings, the sides of which are coated with thin plates of calcedony, and, according to Captain Jenkins‡, of calc spar. These minerals are not confounded with the substance of the basalt, and may be the result of infiltration or sublimation of siliceous and calcareous matters. In no other situation did I meet with an example in which either of these processes would account for the occurrence of the calcedonies, zeolites, calc-spar, &c. found in the amygdaloids and nodular basalt of India. Almost everywhere, calcareous spar is more rare than siliceous minerals, which would not be the case were they derived from infiltration, if we are to interpret the past by the present operations of nature. Wherever I have met with the basalt, and in the neighbourhood of every greenstone dike or insulated mass of that rock, and under every layer of basaltic soil in India, calcareous matter is deposited, and has even occasionally a crystalline structure. In the escarpments of the Mysore ghâts, veins of basalt, not two inches thick, ramify through the granite, and are coated with a compact layer of carbonate of lime. Voysey found the granite in the neighbourhood of the basalt intermixed with calcareous matter, indications of which I have myself seen, in the deposit of tuff on the summit of granitic logging-stones near greenstone. If, then, we suppose infiltration to have deposited the calcedonies, agates, &c., &c., when chemical action is presumed to have been more powerful than at present, a greater number of the cavities would have been filled with lime than with such intractable substances, which is not the case. These are also frequently intermixed with the basalt in a manner which could

* Asiatic Researches, vol. xviii.

† Geological Transactions, Second Series, vol. 4th, p. 410.

‡ Asiatic Researches, vol. xviii., p. 199.

have been produced only by their being formed simultaneously. I have seen masses of calcedony, passing into a black mineral not to be distinguished from the surrounding basalt. They also occur in the compact nodules where no fluid could have had access, and even in the cavities of the Seetabuldee basalt, lined by an impervious glassy coat. In this rock, likewise, calc spar occurs, penetrated by needle-like crystals of the same substance, invested with a crust of the basalt and connected with each side of the cavity, and resembling chiastolite in structure. It is indeed impossible to conceive how many of the appearances presented by the agates, cornelians, or drusy cavities in calcedony, partially or entirely filled by quartz crystals, or a central mass of calc spar, could be formed in the way supposed, as the first coating of silex would effectually close out the further access of the aqueous solution of that substance; nor could layers so formed, separate into distinct cavities, having both sides covered with quartz crystals, as they are sometimes seen to do. It is, however, only by a careful study of the rocks themselves, that this can be fully understood. I have selected a few specimens to show that the majority, if not all the minerals of the Indian trap rocks, are not formed by infiltration. One of these, perhaps, deserves particular notice; it is a mass of calcedony, 8 or 10 inches in length and 6 or 8 in diameter, of a conical shape, and was found imbedded with its apex downwards between the globular basalt, and impressed with the irregularities of its surface. In another of these specimens the upper part is perfectly flat and smooth, without any impressions of the basalt, and is composed of a thick covering of cacholong, parallel stripes of which appear to indicate the slow cooling of the surface. The centre of the mass is composed of quartz crystals, radiating to the centre, which is occupied by calcareous spar impressing or impressed by the quartz. The mode of its occurrence increases the conviction in my mind, that the only correct theory of the formation of such minerals in trap rocks, is the play of the molecular attractions existing between similar particles of matter. That so eminent an inquirer as Dr. Turner should have asserted that all calcedonies, rock crystals, &c., even when occurring in volcanic rocks, are the result of aqueous infiltration*, I can only account for, by the difficulty of explaining how carbonic acid is retained at high temperatures, in any other way than by supposing a great pressure to have existed at the time the rock was in an ignited state; but of the existence of which, proof is often entirely wanting where crystals of carbonate of

* Lecture on the Chemistry of Geology, by Dr. E. Turner, Edin. New Phil. Journal, Oct., 1833.

lime occur. The phenomena exhibited by the vesicular trap, scoriæ, and porous chert associated with the Indian basaltic and fossiliferous rocks, satisfied me, that at the time of their formation they were subject to no pressure sufficient to retain the carbonic acid of the altered limestones, and of the shells and calc spar inclosed in the geodes; but no other explanation presented itself, till I was informed by Mr. Faraday of his beautiful experiment of exposing carbonate of lime in perfectly dry air to the heat of the oxy-hydrogen blowpipe, without driving off its carbonic acid. In the simple apparatus employed by him to show that the retention of the acid depended on the absence of moisture, no pressure of any consequence could be exerted on the lime. Guy Lussac has lately published some experiments on the effect of aqueous vapour in assisting the escape of carbonic acid from limestone, and concludes, that its agency is trifling*; but as he does not appear to have taken the precaution of drying the atmospheric air by passing it through sulphuric acid, as was done by Mr. Faraday, they cannot be considered as invalidating the beautiful results obtained by the latter. His observation, however, that the water contained in limestones is driven off before the carbonic acid and at a much lower heat, is important, in showing that the calcareous matter in a rock exposed to volcanic action may lose its water before the carbonic acid, and be thus reduced to the state of the carbonate of lime in Mr. Faraday's platinum tube. These facts will assist in explaining the anomalies observed in the fossils of the district above referred to, which often retain their carbonic acid when portions of the rock in which they occur have been fused by the inclosing basalt, while other portions are vesicular from the escape of gaseous matters. The whole phenomena, indeed, would admit of explanation by supposing, what must in fact have occurred, the presence or absence of moisture during the various degrees of heat to which the rocks were exposed in the progress of the eruption, and in the course of cooling. A shell, in one part of a rock, may thus retain its carbonic acid, while in another portion it may be reduced to quick lime, subsequently carried off by the water, leaving only a cast; and a third may be replaced by silica, or the form of its convolutions taken by fine quartz crystals, perhaps derived from silica rendered gelatinous by the lime with which it was ignited†.

In stating these views, I venture only to express an opinion forced on me by the phenomena under description, and which appear to explain

* Annales de Chimie et de Physique, Oct., 1836.

† For a knowledge of the fact, that lime calcined with finely-divided silica, acts like he fixed alkalis in rendering it gelatinous and soluble in weak acids, I am indebted to Capt. Smith of the Madras Engineers, F. R. S.

some of them better than the theory of pressure, which, however useful in removing the prejudices against the igneous origin of the trap rocks, has been injurious in leading geologists to admit too easily the existence of aqueous pressure, or extensive denudations of solid rocks, supposed to have confined the carbonic acid at the time of eruption. No doubt pressure is an efficient agent in some cases*, but not in many to which it has been applied.

The trap terminates in the line of section, a few miles to the north of the city of Nagpoor, and is succeeded by a red sandstone, the strata of which are bent, fractured, and converted into a compact quartz rock, at the point of contact with the granite which has burst through it. Within a few hundred yards of the ravine where these phenomena were observed, mica slate occurs, and a little beyond, some hills of gneiss. A bed of granular limestone is quarried at the foot of a conical hill of basalt, in part composed of a scabrous quartzose, and calcareous rock, abounding in drusy cavities, calcedonies and cornelians. Further north, granite veins pass through a much-elevated limestone, varying in colour from red to gray and black, and the stratification of which is nearly obliterated. The gneiss and mica slate forming the neighbouring hills are also penetrated by dykes and masses of granite†. To the north of this district are 50 miles of a wild mountain country, composed of granitic rocks, with trap in the ascents and tops of the passes; the basalt then reappears, and composes great part of the valley of the Nerbudda.

In a direction south-west of Nagpoor, the nodular basalt is the only formation met with as far as Baitool (90 miles), where granitic rocks reappear, but are succeeded by fine-grained sandstones with traces of coal, and penetrated by trap dykes ranging from S.E. to N.W‡. Here, the sandstone rises into mountains, and constitutes what appears to be the continuation of the range forming the division between the valleys of the Taptee and Nerbudda rivers; and "indurated clay," containing casts of the same shells as those of the Sichel range, also occurs.

Before proceeding to notice more particularly the fossils, and the evidence they afford of the geological era of the intrusion of the basalt, it is necessary to make some observations on the Sichel range, and the connexions of the several formations occurring in the district described. The basaltic rocks of Nagpoor and of the country to the south, have been

* Transactions of the Royal Society of Edinburgh, vol. vi., p. 120.

† Captain Jenkins, in Asiatic Researches, vol. xviii.

‡ Lieuts. Miles and Finnes, Journal of the Asiatic Society of Bengal, Feb., 1834, and Dr. Spilsbury, August, 1834.

considered by every observer to form the eastern part of the great basaltic formation of Western India, with which it is continuous, and with which it agrees in every particular of general character and mineralogical structure, and in being connected with stratified rocks, which, as far as is yet known, are of the same age. The only difference is, that towards the eastern limits of the formation, the hills are less elevated and the trap breaks through the granite and stratified rocks, while to the west the mountains are, with a few exceptions, entirely composed of basalt from the level of the sea to the loftiest summits.

Lonar Lake, &c.—The Sichel hills, which have heretofore attracted little attention in a geological point of view, terminate to the west in the neighbourhood of Lonar, near what appears to have been a vast crater in the centre of the great basaltic district. As it is the only instance of a volcanic outburst discovered in this immense Plutonic region, a more detailed account of it than has yet been given to the public, may not be unacceptable*.

It is a nearly circular or oval depression, in a country composed of tabular and nodular basalt, and sloping gently towards it on every side. It is between three and four miles in circumference at the upper margin of the precipitous escarpment which rises from the bottom of the valley about 500 feet. The extent from which the water is collected may be about six miles in circumference, but no measurements were made. Two small streams fall into it from above; one issuing from a pagoda, to which it is carried from the gentle slope behind; and the other passes over a small cliff, (Pl. B.) on which it deposits a considerable quantity of stalactite. The sides of the crater are covered with a forest inhabited by tigers and game; and the bottom is occupied by underwood, a few fields, in the irrigation of which the water of the streams is nearly expended, and by a small lake of salt and bitter, greenish water, surrounded by a muddy shore, and varying in size at different seasons. Many sweet springs issue from the saline mud, and a well is built within its highest level, the water of which stands at the same height as that of the lake, though issuing from a depth of nearly twenty-four feet.

I have carefully examined the water of this well, and that of the small stream at the pagoda above. This last had a specific gravity of 1000-6;

* Captain Alexander has published a notice of this lake in the Transactions of the Literary Society of Madras, and in the Edinburgh Philosophical Journal; but he must have examined it very cursorily or he would not have overlooked its real nature, and stated it to be unfathomable, when, in fact, the water is everywhere shallow. An extract from a private letter to Mr. Prinsep, and published in his Journal for June 1834, was written before I had myself examined the chemical history of the lake.

and 2000 grains, evaporated at 212°, gave a solid residue of $\frac{7}{10}$ of a grain, the greater part of which consisted of muriate of soda with a little sulphate, and the remainder of carbonate of lime. The water of the well below had nearly the same specific gravity, but contained in 2000 grains, one grain of solid matter, of which $\frac{7}{10}$ of a grain were soluble in water, and contained muriate of soda and a little sulphuric acid and lime; the insoluble part consisted of carbonate of lime. Neither of the waters contained any trace of alkaline carbonates or of magnesia. It is unnecessary to go further into the analysis here, as another bottle of the same water had a higher specific gravity, and contained more lime, a circumstance sufficiently accounted for by the escape of a portion of the carbonic acid from the other specimen. The water of the lake is clear, and has no unpleasant smell; but the mud at its bottom is strongly impregnated with sulphuretted hydrogen. In February, 1834, when the specimens were collected, the lake was in no place more than 5 feet in depth of water and mud, but when full it may be eight or ten feet deep in some parts. A layer of salt 2 or 3 inches thick covered the bottom *under the mud,* and when broken up and removed, was found to be composed of a middle plate, with radiating laminæ above, and having a striated appearance below. That obtained by diving and bringing up baskets of the black mud, at a season when there was much more water in the lake*, was also formed under the surface of the mud in lamellar spiculi radiating in every direction†. The salt accumulates slowly, and is collected only once in several years, the quantity having diminished in consequence of the mounds erected above the edge of the crater to regulate the supply of water, having been neglected; but it is evident, from the great beauty of the specimens obtained, that the quality is not affected by this cause. The salt is collected at the end of the dry season, when the water is low; and I observed mounds of the black mud on the banks, covered with an efflorescence of tabular crystals. The salt is used for washing and dying chintzes, &c., and is exported to considerable distances. I imagined that the water of the lake in which such large quantities of salt were deposited, was saturated; but I found its specific gravity to be only 1027·65, a solution of the salt itself obtained from the bottom at the same time being 1148·4; and the water rapidly dissolved the crystals thrown into

* July, 1824.

† The natron of a lake near Maracaybo in South America occurs in the same way, the Indians breaking up the layers of salt with long poles; and then, by diving, they remove it from under a bed of mud which covers it, and they place it in small canoes, as is done at Lonar. Journal of the Royal Institution, vol. i., p. 188.

it. On analysis, the salt was found to consist in 100 parts: of carbonic acid, 38; soda, 40·9; water, 20·6; insoluble matter, ·5, and a trace of a sulphate. This nearly corresponds to the composition of the trona or striated soda from the lakes of Fezzan, examined by Mr. R. Phillips*; but approaches somewhat nearer to the equivalent numbers of the sesquicarbonate established by that analysis, which is to be ascribed to the greater purity of the Lonar salt. The water of the lake contained besides, a little potash, muriate of soda 29 grains, sesquicarbonate of soda 4·2 nearly, and sulphate of soda ·1 of a grain in 1000 grains of the water. No lime could be detected in it, nor did I discover any magnesia. These facts confirm Berthollet's theory of the formation of carbonate of soda in the natron lakes of Egypt, viz. that of a mutual decomposition of the muriate of soda and carbonate of lime when in a pasty state.

The striated soda of Fezzan and of this lake, containing half an equivalent more of carbonic acid than can be furnished by carbonate of lime, renders some modification of his theory necessary; and the most probable explanation appears to be, that the carbonic acid by which the lime is held in solution in the mud, furnishes the acid, and perhaps indicates the existence of an unstable sesquicarbonate of that substance; which is not improbable from other facts in the history of the union with that acid. This was suggested by my friend Captain Smith, of the Madras Engineers, and explains the circumstance sufficiently.

Like most points in physical science, these observations have other and more extensive applications than that of affording an explanation of the production of natron in this lake. Carbonate of soda is extensively distributed over the surface of the soil in various countries, more especially in the basaltic portion of Central and Western India, and in the limestone districts of the south; the real relations of which have been a subject of discussion amongst Indian geologists, and inferences unsupported by fact have been drawn from it. In all the places where I have met with it, or of which detailed information has been obtained, muriate of soda and carbonate of lime existed in the soil, and the natron was found on the surface of the moist earth or mud. Near Gundycottah on the banks of the Pennar, common salt is interstratified with the upper schistose strata of the argillaceous limestone on which the sandstone rests; and on the surface of the neighbouring soil, natron, contaminated with much muriate of soda, is collected and used in washing and in glass-making. The salt associated with the limestone, and the water of a saline well dug through it, having the specific gravity of 1002·5, contain

* Journal of the Royal Institution, vol. vii., p. 294.

common salt and a little sulphate without any carbonate of soda, which is no doubt produced in the same manner as the Lonar salt. I did not ascertain whether it was also a sesquicarbonate, but I have examined a portion of native carbonate of soda from another part of India, with which Mr. Faraday had the kindness to furnish me, and I found it to be composed of a mixture of that salt with muriate of soda and a little sulphate. The same is probably true of the carbonates found in other countries in similar situations*. A specimen, however, procured from the water of a deep well near London, passing through the London clay into the chalk, which I received from Professor Daniell, contained the carbonate ; but as the sesquicarbonate is decomposed by a low heat, no inference can be founded on the examination of specimens obtained, as this was, from the boiler of an engine.

The absence of Lime in the water of the Lonar Lake is a remarkable circumstance, but easily accounted for, as the sesquicarbonate of soda and the water itself precipitate the sulphate and muriate of lime, notwithstanding the mutual decomposition they undergo when in a semifluid state. The Lake of Ourmia, in Persia, is stated by Dr. Marcet to contain no lime, although of a specific gravity of 1165·07, and abounding in sulphates and muriates. This appeared very remarkable in an inland sea nearly 300 miles in circumference, situated in a volcanic country. On referring to the works of travellers†, it appeared that the streams flowing into it abounded in lime, which is deposited in large quantity in the form of a beautiful travertine. The lake is shallow, and at certain seasons much of it is nearly dry ; the water is clear and transparent, but the mud of the bottom is loaded with sulphuretted hydrogen, and thick layers of salt, formed in it under the water, are redissolved on any agitation. No fish can live in it. All these phenomena are exact counterparts of those exhibited at Lonar, but no information is given as to the salt collected from its saline mud, except that Sir John Malcolm states, the salts are bitter and different from those of the sea. I am, therefore, strongly impressed with the conviction, that sesquicarbonate of soda is formed from its waters as at Lonar, and precipitates the lime. Dr. Marcet, however, has given, in the Philosophical Transactions for 1819, the results of an examination of a small quantity of this water, which he states to be as follows :

* The carbonate of soda formed by the incineration of saline plants in the deserts of Northern India, and by the deflagration of nitrate of soda and charcoal in the south of the Peninsula, must not be confounded with the natron found in the soil.

† Sir John Malcolm's History of Persia ; Sir Ker Porter's Travels ; Ouseley's Travels ; Journal of the Geographical Society, vol. iii. &c.

1. Precipitate from 500 grains of the water by nitrate of silver.......................... .... 237·0
2. By nitrate of baryta.. 66·0
3. Magnesian precipitate by carbonate of ammonia and phosphate of soda....................... .... 10·5

and he infers, that although it contains no lime, it yields twenty times as much sulphuric acid and six times as much muriatic acid as sea water does. But Dr. Marcet had only 150 grains of this water to operate on, and merely gives in a tabular form, along with many specimens of sea water, the quantity of precipitate caused by the various reagents; and there is no evidence that the precipitate from muriate of baryta was not, in part, caused by carbonate of soda. It is, at all events, worthy of the inquiry of future travellers*.

The Lake of Ourmia, like that of Lonar, contains potash, which I did not detect in the springs running into the latter, but its source is no doubt in the decaying (and when I visited it, burning) trees on the surrounding precipices. The sulphuretted hydrogen adhering to the clay has been supposed to be derived from volcanic sources, but I have observed the same phenomenon in the salt water inlets along the Indian coast, wherever the bottom contained argillaceous and carbonaceous matter; and it even goes so far as to form considerable quantities of sulphur and, I have reason to believe, sulphuric acid, although on this point the proof is defective. The effect is to be ascribed to the decomposition of the sulphates of the water by the carbon; and the clay probably only prevents its passing off into the air or mixing with the water, by the power of adhesion. Similar actions have gone on in former times in the alluvium on which the city of Madras stands, and probably in more ancient deposits†.

The ancient crater of Lonar seems never to have been an active eruptive vent, as no scoriæ or lava currents can be traced around its margin, which is too distinct and unaltered to admit of any probability of these having been subsequently removed by denudation. A certain degree of forcible elevation was sustained by the margin of the lake, when the

* If a carbonate exists in the water, it must be of the same composition as that of Fezzan, Maracaybo, and Lonar, as the carbonate would precipitate the magnesian salt, which the sesquicarbonate would not.

† No sulphuretted hydrogen can be detected in the water of the springs running into the lake. The hot spring of Anhoni Simhoni, in the sandstone and basaltic district between the valley of Berar and the Nerbudda, I have found to contain sulphuretted hydrogen and muriate of soda, without lime.

explosion or subsidence happened from which the great depression took its origin.

From Lonar the basaltic district extends to the south as far as Beder; to the west, 200 miles to Bombay; and northward, to the banks of the Nerbudda, near the ancient cities of Indoor and Mhysir, reported to have been buried at a remote period under volcanic eruptions. To the east, the great basaltic country of Berar extends as far as Nagpoor; and the Sichel range passes in a S. E. by E direction to the confluence of the Wurdah and Godavery, and towards the eastern ghàts. Hot springs and streams loaded with carbonate of lime, occur along the line of elevation of these mountains at Mahoor, Urjunah, Kair, Byorah, and at Badrachellum, a short distance above the pass through which the Godavery reaches the alluvial plains of the coast. The spring of Byorah is surrounded by sandstone and limestone rocks, and carbonic acid escapes with the water, which has a temperature of 110° and holds lime in solution*. That of Badrachellum, which rises in the sandy bed of the Godavery, has a temperature of 140°, and contains sulphuretted hydrogen, also sulphates and muriates of soda and lime. A sandstone resembling the cement of the Bangnapilly diamond breccia and the rock of Won, protrudes from the sandy bed of the river near the spring; and granite, basalt, and a red schist resembling that so common in the diamond districts, occur in the neighbourhood; diamonds also are occasionally found. Other hot springs are reported to exist in this line of elevation; but that wild and little-known country, far removed from the residence of any European, must long remain in a great measure unexplored.

The facts stated in the preceding pages prove that the basaltic rocks, by which so much of Western and Central India are covered, are more recent than the sandstone and argillaceous limestone of the basins of the Pennar, Kistnah, Godavery, and of the mountains south of the Nerbudda; and that, notwithstanding the frequent occurrence of these rocks in a horizontal position, they have been subjected to violent operations, which have in many instances elevated the strata and remarkably altered the rocks themselves. It also appears, from observations made on the borders of the trap districts, and in other places where the primary rocks and the sandstones and limestones are not entirely concealed, that the basalt has burst forth from numerous fractures in these formations, probably simultaneously, although often forming insulated masses. It is possible, that more than one period of eruptive violence may have occurred between the era of the formation of the greenstone dykes, so

* Journal of the Asiatic Society of Bengal, vol. ii., p. 397.

common in the granitic districts, and the conclusion of the eruptions by which the fossils were entombed; but at present there is no proof of such having been the case; and all observers have considered the eruptions to have been contemporaneous; an opinion, to a certain extent, confirmed by the occurrence of the same fossils in very distant localities.

The sandstone and argillaceous limestone I have myself traced, from the neighbourhood of Nagpoor nearly to the junction of the Wurdah with the Godavery, bearing the same characters as in the vicinity of the fossil beds; and I have collected specimens of the same rocks at various places between this and Badrachellum and the diamond mines in the neighbourhood of the Kistnah. This tract, for 250 miles, is nearly an uninterrupted forest, and presents many difficulties in the investigation of its geological structure. Trap rocks and basaltic soil occur in many parts of the course of the Godavery, and granite of the usual character is occasionally met with. Dr. Voysey, who investigated great part of it with his usual accuracy, describes the sandstone as constituting a range of mountains 60 miles in extent, to the north-west of Badrachellum; and the surface rock 20 miles south of Ellore (near the alluvial plains of the Kistnah and the diamond mines), also at Mungapett on the Godavery, where I found silicified wood resembling that of Pondicherry*. Fossil wood was also seen by Mr. Geddes strewed over the country N.W. of this point, towards the junction with the Wurdah. Where the sandstone of the Godavery meets the granite to the west, Dr. Voysey states that it can hardly be recognised as the same rock, consisting of a conglomerate containing quartz, felspar, and rounded pieces of granite resembling that of the eastern ghàts. The argillaceous limestone occurs in the same district, and is more widely distributed than Dr. Voysey supposed. He found it at an elevation of 2600 feet above the sea, and exhibiting marks of great disturbance, dipping to the S.E., and at the summits of the hills intermixed with quartz rock†. Dr. Voysey considers these formations at the lower part of the Godavery, to be the same as those of the Kistnah and Pennar; and in this opinion I fully coincide, although I have found the continuity of the sandstone and

* Journal of the Asiatic Society, vol. ii., p. 402. The tenor of Dr. Voysey's observations in this place seem to show that he considered the "clay slate," in which he included the sandstone, to belong to the same formation as the limestone; a conclusion I had formed before meeting with his paper, and which has not been expressly stated in any of his writings yet given to the public.

† The structure of the wood is beautifully preserved: it is coniferous. June 24, 1839.

argillaceous limestone to be interrupted by a narrow band of granite, extending from the delta of the Kistnah to the granitic platform of the Deckan. Some of the hills, however, have caps of sandstone. In the present state of our knowledge, it is difficult to form any correct notion as to the dip and direction of these rocks. Indications of derangement and elevation by the granite are, however, sufficiently apparent.

Sandstones and schists of the same characters, and associated with the same rocks, are also extensively distributed along the great tributaries of the Kistnah, in the southern Mahratta country, near the western ghàts, and a little to the south of the part of the basaltic district described by Colonel Sykes (Geol. Trans., 2d Series, vol. IV.). The limits of this part of the formations have been but imperfectly traced. According to Dr. Christie's observations and my own, they are the same as those of the Cuddapah district*. The occurrence of sandstones and stratified limestones in this situation, is a fact of great importance, which has escaped the notice of those, who have speculated on the period of elevation of the great mountain chains of the peninsula. It was for this reason, that I selected the line of section from Madras to Atchera, on the western coast, within the limits assigned by Colonel Sykes to the basalt, and near to which I discovered the sandstone *below* the escarpment of the western ghàts. (Plate, Section 2). In the pagoda of the town, I observed several quartzose sandstone pillars; and I discovered the rock itself forming a small range of hills to the south of the town, and dipping at a considerable angle to the N.W. The stone is similar to that of the hills, near the Chinoor diamond mines. The rock at the entrance of the inlet is laterite, having the appearance of horizontal stratification; and there are some indications of trap below it; but of this I could not obtain positive evidence. Colonel Sykes, however, states that the basalt occurs a little to the south at Malwan; and I found it at Colter, and other places to the north, underlying the laterite, at the foot and on the escarpments of the hills. These facts are sufficient to show, that the elevation of the western ghàts in this part of their course, was posterior to the deposition of the sandstones, which, for the present, must be considered as contemporaneous over all the districts described. I am aware of the uncertain nature of mineralogical characters, as characterizing different formations; but in rocks exhibiting such remarkable appearances and relations over such extensive areas, and when no organic remains exist in them, I do not think it wrong, to place some confidence in the evidence they afford, more particularly in the south of India,

* Edinburgh New Philosophical Journal, 1828 and 1829.

where the rapid changes of formations, so common in Europe, are quite unknown.

The speculations of Elie de Beaumont on the age of these mountains is founded on negative evidence and analogies which appear to me to have little weight; nor can I consider the remarks of Dr. Benza, founded on his excellent researches on the geology of the Neilgherry mountains, as more conclusive. The non-occurrence of stratified rocks and of organic remains in a high granitic table land, affords no proof that these mountains have not been recently elevated; and the plentiful occurrence of ferruginous sandstone, containing brown coal, lignite, and mineral copal, at the foot of the Travancore mountains, show that these inferences have been too hastily drawn, when such gigantic generalizations were to be established.

Age of the Diamond Sandstone and Argillaceous Limestone.

With regard to the age of the diamond sandstone and argillaceous limestones, my own conviction is, that they belong to the more ancient secondary, or even transition rocks; an opinion, which is not at all contradicted by their frequent occurrence in horizontal strata, as they could not have been deposited in the situations in which they are now found. The facts I have stated, will enable others to estimate the correctness of an impression founded on the structure, geological relations, and occasional nearly vertical position of the strata. On this subject, I would express no decided opinion, but recommend an examination of the junction of these formations with the stratified and unstratified primary rocks, with a view to this question.

The sandstones and limestones of Bundlecund and Malwa correspond in many particulars with those of the south of India, and have been considered by all writers as belonging to the same formations. The sandstone, Major Franklin considers to be the same as the saliferous sandstone of England*; to which it has been objected, that the salt diffused through the soil of Bundlecund may not be derived from this source, as it has never been discovered in that rock. I have also ascertained that salt occurs in all the formations of India, from granite to recent alluvium. I have, indeed, never met with a saline spring in the sandstone, but this I consider to be accidental, that rock being generally placed in inaccessible situations. I have, however, found thin seams of salt, interstratified with the upper schistose layers of the argillaceous limestone, in the

* Geol. Trans., 2nd Series, vol. iii., Part I.

immediate neighbourhood of a cliff of sandstone 300 feet in height, between the lower beds of which a similar schist was interposed. A more important objection to Major Franklin's opinion of the diamond sandstones belonging to the new red sandstone is, that in the peninsula, this sandstone, throughout 800 miles of latitude, and half as much of longitude, is *superior* to the limestone he has called "Lias." Nor can I find sufficient proof in his memoirs, or in other papers on the country between the Nerbudda and the Ganges, that this limestone reposes directly on the sandstone; and it is evident, that no inference can be founded on its occurrence at a higher level in a country so much altered by denudation and the intrusion of eruptive rocks. But should it be hereafter found, that the limestone in certain parts of Bundlecund does actually occupy a higher geological position, the fact would not be conclusive against the diamond sandstones of the north and south, belonging (as every thing indicates) to the same formation. I am indeed of opinion, that the argillaceous limestone and the sandstone constitute only one formation, although I do not think that they should be spoken of as such in the present state of our knowledge. The basalt which has broken up and penetrated these rocks to the north and south of the Nerbudda, is connected with the same system of trap rocks, and was probably erupted at a period much more recent than either of those to which the sandstones and limestones have been referred.

Inferences respecting the Freshwater Fossils.

On the evidence on this subject afforded by the fossils imbedded in or covered by the basalt, I shall now make a few observations. For the descriptions of the shells, I am indebted to Mr. J. De Carle Sowerby*.

The e fossils all belong to freshwater genera, and to species which have not yet been discovered recent. I have not been able to obtain the seeds of Asiatic *Charæ,* nor the valves of any *Cypris* inhabiting the fresh waters of India. The shells, however, all differ from those inhabiting the rivers of the neighbouring country, as far as Mr. Sowerby and myself could judge, by comparing them with a collection of recent shells, which I made during a residence of several years at Nagpoor; nor do I think it possible that any of the larger shells could have escaped my notice, did they still inhabit the northern branches of the Godavery. Colonel Sykes, also, had the kindness to allow me to examine a collection of recent shells made by him near the western ghats, consisting of the same species as

* See Plate, and Description.

those of the Berar valley, and they are of course different from the fossils. I also failed to detect amongst them any of the shells contained in a large collection of recent land and freshwater Testacea from Bengal, presented to the Zoological Society by Mr. Benson. It may therefore be inferred, that the fossils do not belong to recent species.

Gyrogonites have not yet been observed in any deposit more ancient than the freshwater formations of the basin of Paris. Cyprides occur in the tertiary strata, and in the Weald clay below the chalk, and perhaps in the Birdiehouse limestone of the Edinburgh coal-field. Of the other five genera discovered in these fossil beds, two have hitherto been found only recent or in tertiary deposits, viz. *Limnea* and *Physa;* and the best characterized specimens of some of the others are referable to the same period. It is therefore extremely probable, that the basalt in which these fossils are imbedded, and which has altered the rocks in which they occur, belongs to the tertiary epoch; but to which period, I fear we have not the means of forming any decided opinion. Though none of the species are recent, yet they are too few and in too ruinous a state to admit of any general conclusions; although, from the very great number of individuals collected in various localities, without adding any fresh species, it is probable that nearly the whole which exist have been procured. But when the vast extent of the country occupied by the basalt is considered, and that a still greater tract was broken up or disturbed at the time of its eruption, it will not appear improbable, that a rule, founded on the disappearance of marine shells in districts exposed to no such extensive causes of destruction of animal life, should not apply.

In the preceding pages, I have described the fossils discovered by Mr. Geddes and myself in various parts of the Sichel mountains, and the Valley of Berar, extending through the great trap district for 140 miles; and I shall now shortly refer to other localities at great distances from each other, where the same fossils have been found in similar rocks, buried under the basalt.

Other Districts of India in which similar Freshwater Shells have been found.

Dr. Spilsbury discovered, eighteen miles from Jubalpoor, in an undulating plain studded with irregular masses of trap, blocks of "indurated clay," containing casts of fossil shells, for the most part siliceous, and resembling those discovered by Dr. Voysey in the Gawilghur range*. At

* Journal of the Asiatic Society of Bengal, vol. ii., p. 205.

Saugor, nearly 100 miles to the north-west, reversed shells, stated to be exactly the same as those of Jubalpoor, were discovered by Dr. Spry in a bed of limestone, entirely surrounded by an amphitheatre of trap hills, in which a lower range of compact sandstone is included*. This fossiliferous limestone is covered by 17 feet of basalt, and rests on a coarse siliceous grit, under which basalt is again met with. In the same neighbourhood fine specimens of silicified palms are found. Jubalpoor and Saugor are situated to the north of the Nerbudda, in the great Vindya range; and in the same district fossil bones of Mammalia occur in limestone capped by basalt. The drawings of the shells differ a little from each other†, but the fossils are stated to be the same; and, as far as Mr. Sowerby could judge, they do not differ from the *Physa Prinsepii*. The similarity was more obvious in other specimens left in India, and I have no doubt of their being the same. It is, however, desirable that the specimens themselves, in the Museum of the Asiatic Society of Bengal, should be compared, that the connexion of the northern and southern portions of the trap formation may be placed beyond a doubt. South of the Nerbudda, fossils are again met with in the mountainous country, north of the sources of the Taptee, at a place called Jirpah, near to which trap hills have broken through the sandstone. Dr. Voysey, in speaking of the heat of the steel furnaces of Neermul, notices the occurrence of an "indurated clay" containing fossils at this place, but he gives no further information regarding them‡. In a small specimen of this rock, Mr. Sowerby recognized the *Paludina Deccanensis*, and a portion of a larger shell, probably the *Physa Prinsepii;* and the matrix is the same as the fossiliferous "indurated clay" from Gawilghur; it also much resembles many of the varieties of chert in which the Berar fossils are found. The third range of hills has been described by Dr. Voysey under the name of the Gawilghur Mountains, and it forms a very remarkable feature in the physical geography of Central India. In this lofty basaltic range, Dr. Voysey discovered fossil shells, the situation of which he has accurately described§; but as his account of them, has been so far misunderstood, as to induce Mr. Conybeare to state that they occur in "lias-like beds‖," and Colonel Sykes in a recent

* Journal of the Asiatic Society, pp. 376, 639.

† Ibid., p. 583, Plate 20.

‡ Ibid., vol. i., p. 247.

§ Asiatic Researches, vol. xviii., p. 187.

‖ Report to the British Association, 1832.

deposit*, it is necessary to mention that they are found in mountains in great part composed of basalt resembling that of the Giant's Causeway, but containing, more frequently, crystals of olivine, of basaltic hornblende, and carbonate of lime. This rock passes into a wacké, having every variety of structure and induration known amongst trap rocks, or into what has been called stratified basalt, from the parallelism of its planes, "the summits of many of the ravines presenting a continued stratum for many thousand yards†."

Ascending from the Taptee river, Dr. Voysey‡ observed a group of basaltic columns, and near the summit of the flat table-land of Jillan, he entered a pass presenting a perpendicular section, above the road, of 30 feet, and below it, a rapid descent of between 40 and 50. The lower part of the section, as well as the pathway, is composed of wacké, and "lying on it, is a stratum of earthy clay of different degrees of induration, 20 yards in length and about 2 feet thick, containing a great number of entire and broken shells," which are much compressed, and do not effervesce with acids. Some of them completely commix with the matrix. This bed of clay possesses all the characters of a stratum, which Dr. Voysey says, seems to have been depressed by an overlying mass, 15 feet thick, of the nodular basalt or wacké so common in these hills. The vertical fissures, which are so "remarkable in trap rocks, are prolonged from both the upper and lower rocks, into the shelly stratum, although there is no intermixture of substance." The stone in which these fossils occur, is similar to that of Jirpah, and of many of the specimens from the Sichel range and the valley of Berar; and the casts and fragments of the shells resemble those of the Paludinæ and other shells of that district. Between these mountains and the Sichel hills, the great valley of Berar is included, but the two ranges closely correspond in the nature of the soil and rocks, and in their fossiliferous beds. They are not, however, exactly parallel; nor do I think, that we are justified in classing them with the Vindya range to the north of the Nerbudda, or with the range which separates the valley of that river from the valley of the Taptee.

It is evident, from the same fossils being found in all these ranges, several hundred miles distant from each other, and from the same secondary rocks being broken up and altered, that the basalt of which they are principally composed was, in part at least, erupted at the same time;

* Geol. Trans., 2d Series, vol. iv., p. 426.

† Dr. Voysey, Asiatic Researches, vol. xviii., p. 127.

‡ Asiatic Researches, vol. xviii., p. 192, and Journal of the Asiatic Society of Bengal, vol. ii., p. 304.

and that the western and eastern ghàts must have partaken in this great movement.

Shells, probably of the same genera, were also found by Dr. Voysey in the insulated basaltic hills of Medcondah* and Sivalingapah, which rest on the granite of the Deckan, south of the Godavery, and are probably connected with the southern part of the great trap district, and the hills of Bicknor Pett and Nugger shown in Section 1. The fossils are imbedded in the basalt, in a siliceous rock containing lime, and corresponding in specific gravity, chemical composition, and appearance to the fossiliferous cherts of the Nirmul Hills. Sivalingapah lies considerably to the west, but nearly in the same latitude as Nirmùl.

The only other locality where fossil shells have yet been discovered, within or near the great basaltic district, is five miles south of Rajahmundry, a large town on the Godavery, a little above the alluvial plains of its Delta†. They occur in some small hills ranging nearly W. and E., and composed of conglomerate and red sandstone supporting wacké, overlaid by limestone containing shells, which is again covered by basalt. The shells are in the best condition in the upper part of the limestone; of many only the impressions remain, but the oysters, which are the most abundant, are well preserved. The basalt and some specimens of the chert, jaspers, &c., from these hills, presented to me by Dr. Benza, resemble the varieties found with the freshwater shells of the Sichel range, and the hills in which they occur having the same direction, are probably connected with the eastern termination of that range. They are evidently associated with the sandstones of the diamond districts to the north of the Kistnah, and with the continuation of the eastern ghàts; thus confirming the opinion above expressed, of these mountains being of more modern elevation than is supposed by some geologists. It is impossible to separate the western ghàts from the eastern in any theory that can be formed, as they diverge from the same point, support the same table-lands and the same stratified rocks; and where these mountains meet at the Neilgherry Hills, the hornblende schist has been noticed by Dr. Benza to dip in opposite directions from the eastern and western mountains.

In the Journal of the Asiatic Society of Bengal, vol. iv., p. 565, and

* In a specimen of this chert in the Geological Society's Museum, I have found a gyrogonite of the same kind as those of Nirmul, and halves of a species of *Cypris* associated with shells. June 24, 1839.

† Dr. Benza on the Neilgherries, Journal of the Asiatic Society of Bengal, p. 435., Aug., 1835.

our Plate, fossil shells are figured, which bear considerable resemblance to some specimens of Unio from the Sichel Hills, but not sufficiently to identify them. They form part of the Dadapoor collection of Sub-Himalayan fossils, so ably investigated by Lieuts. Baker and Durand, and are stated by Mr. Prinsep, in a note, to be identical with specimens collected by Colonel Burney with the bones of the Mastodon, &c. in Ava. He adds, that they probably belong to the large and thick species of *Cyrena* noticed by Professor Buckland as occurring in a blue and marly clay near the locality of the fossil bones collected by Mr. Crawford (Geol. Trans., 2nd Series, vol. v.) ; but I found the specimens of these shells in the Society's collection, to differ both from those of the Sub-Himalayahs and of Central India.

Mr. Pentland, in the same volume of the Geological Transactions, makes the following observations on Indian tertiary deposits : " How far " the same formation may be prolonged in a southerly direction along the " peninsulas of Malacca and of Hindoostan it is impossible to say ; al- " though we possess proofs of its existence at Madras, where it contains " the same species of shells as on the Brahma-putra, and at Pondicherry, " where it envelopes the great masses of silicified wood found near that " city." (p. 394). The formation on which Madras stands is, however, erroneously referred to the tertiary epoch, being a recent alluvium, accumulated by the joint action of the rivers and breakers, and containing the same shells as now inhabit the mud of the salt-water inlets and sea-shore of the Carnatic.

With regard to the age of the silicified wood of Pondicherry, no facts have yet been ascertained which can justify any conclusion. It is, however, to be hoped, that a gentleman familiarly acquainted with the tertiary and volcanic rocks of Greece and Italy, will soon communicate positive information regarding the geological relations of the sandstones containing the silicified trees and the fossil shells*, the conical hollows, obsidians, and other indications of volcanic action said to exist in that neighbourhood.

Relative Age of the Laterite and Trap.

I shall conclude this paper by one or two remarks on the relative age of the Laterite and Trap. Dr. Babington† and Dr. Christie had observed this rock, both below and above the ghàts in the latitudes of Seringa-

* The shells I have seen differ from those of Central India.

† Geol. Trans., 1st Series, vol. v., p. 329.

patam and Goa, and I have traced it in the deep and narrow valleys of Coorg, at various heights, from the level of the sea to several thousand feet above it; but as in all those places it rests on syenite or other granitic rocks, from the decomposition of which, *in situ*, there is much reason to suppose that this remarkable formation is derived, no inference as to its age can be drawn from these facts. At Colter, however, and other places on the coast of the great basaltic district, it rests on the basalt, forming the summits of the hills, or an external layer over the trap which constitutes the body of the hill. This superposition is exhibited in ravines passing through the laterite, or where that rock has thinned off so much, that it can be separated from the basalt below, which has most commonly a stratified arrangement, often highly inclined and parallel to the precipitous face of the hill. It has also been observed above the ghâts, and in the table-land of the Deckan, between the Godavery and Manjera rivers, resting on basalt; it is therefore probable, that the trap has been protruded from below since the laterite assumed its present form. It would be improper, in this place, to enter into any details regarding a formation which extends over much of the Malay peninsula, Ceylon, the coasts of Coromandel and Malabar, and Central India. In different portions of these vast countries, several varieties of this rock are met with, well deserving of attention, yet its general character and composition is the same over 30 degrees of longitude and 20 of latitude, and nowhere is any proof to be found of its being of volcanic origin*, or the equivalent of certain European rocks, as supposed by Elie de Beaumont. Under the name of laterite, however, very different rocks have been included; such as the ferruginous clays and sandy beds underlying the alluvium of the Irawady, near Rangoon, and a ferruginous conglomerate now forming in many places from decomposed and reconsolidated laterite or syenite, and containing fragments of granite, and occasionally enveloping a recent land shell.

Besides these, a rock, apparently of igneous origin, has been occasionally confounded with laterite, and in the diamond districts is known to the natives by the same name as is applied to that rock in the Mysore. The thinner strata of the diamond sandstone of the Pennar have been observed to be bent in a remarkable manner by the intrusion of this rock; and in other instances it had apparently escaped in a semifluid state between the joints of the larger tables, carrying with it fragments of the sandstone, whose angles are so well defined, that I thought I could trace the very spot from which they had been broken off. Notwithstand-

* Calder, Asiatic Researches, vol. xviii. Conybeare, Report to British Association.

ing these appearances, the character of the rock differed so much from any varieties of basalt I had then seen in India, that I hesitated about referring it to the trap family, till I had seen varieties of a red wacké much resembling it, constituting part of the basaltic mountains of the island of Salsette. It is in a substance of this kind, interstratified with sandstone, that Tavernier describes the diamond mines of Beejapoor to have been worked in former times. The transitory nature of the political divisions of this part of India, and the decay or desertion of many towns and villages, have hitherto prevented the identification of these mines; but enough has been said to show the importance of caution in reasoning on individual facts, relative to one of the most singular and extensive formations anywhere to be found.

Note.

The freshwater shells described in the preceding pages, must have inhabited sheets of fresh water of which no traces can now be discovered, in the configuration of the mountainous tracts, in which they for the most part occur. No natural lakes exist in these districts, nor could shells have accumulated in such quantity in rivers similar to those which now intersect the country. It may, however, be supposed that the sandstone and limestone rocks of Berar had once a position similar to that which the same rocks now occupy in the basins of the Kistnah and Pennar. Voysey describes these rivers as passing through the Nulla-Mulla range by gaps or fissures " which have been produced by some great con- " vulsion, which at the same time that it formed the beds of these rivers, " gave passage to the accumulated waters of some vast lakes situated " near the outlets." " The tortuous course of the Kistnah is bounded " for upwards of 70 miles by lofty and precipitous banks, which in some " places rise 1000 feet above its level, the opposite sides of the chasm " corresponding in an exact manner. Ravines of this description are not " unfrequent all over the range, and the exact correspondence of their " salient and re-entering angles, together with the abruptness of their " origin, totally preclude the supposition of their being hollowed out " by the action of running water*." Such seems also to have been the case, where the Pennar passes through a narrow gorge in the Gundicottah sandstone hills. Through the upper part of its course, this river flows over a flat country covered with alluvial soil, at right angles to the hills; but it finds an exit

* Asiatic Researches, vol. xv., p. 123, 124.

through them, by a fracture in the wall which in former times had apparently dammed up its waters. The strata have been much disturbed, probably by the eruption of the basalt, which is seen at the foot of the sandstone hills on the opposite side of the valley, from which the Gundicottah range appears to have been separated. Plate, Section 2d. It should, however, be stated, that ravines formed in this sandstone, by the action of the streams now flowing in them, exhibit abrupt precipices, the opposite sides of which correspond to each other as Voysey has described.

The sections accompanying this paper were constructed by Captain Smith, of the Madras Engineers, F. R. S., from information contained in my notes made during several journeys in the lines represented, and from some published papers. The information is by no means complete, but, I believe, it will be found to be correct as far as it goes. In consequence of the great length of the lines to be represented, and the comparatively moderate height of the hills, it would have been impossible to have given the different formations of sufficient size to have been seen in a distinct manner without great distortion of the strata, had the whole distance been represented. Breaks, therefore, have been introduced, representing the continuance of the same rock for the number of miles specified in each instance. In the Baulpilly valley and in some other localities (Sect. 2) the summits of the hills are almost inaccessible, and it has consequently been impossible to represent them as they occur in the exact line of section. I have therefore been content to exhibit the strata as they occur at their bases, with the exception of a few of the hills which have been more carefully examined, and which correspond in appearance to those which are as yet unexplored.

Section 1st passes from the Bangnapilly diamond mines to the valley of the Nerbudda, with the view of connecting Section No. 1, across the peninsula, with a line running north and south through its centre ; and which might easily be continued to the Himalayah mountains to the north and Ceylon to the south.—*Transactions of the Geological Society of London, Second Series, vol.* 5, *part* 3, *pp.* 537-575.

VIII.—*On the Entomology of the Himalayas and of India.—By the* Rev F. W. Hope, F.R.S., F.L.S., *&c., President of the Entomological Society of London.**

It may by some be considered a proof of presumption, that any individual should undertake to describe the entomo-geographical character of a country which he has never visited; and bold, I am willing to allow, is the attempt to embrace, in my views, not only the distribution of Insects in the Himalayas, but those also of the whole Continent of India and its adjacent islands. Possessing, however, one of the richest Cabinets of Oriental Entomology to be found in this or any other country, the major part of the species collected at Calcutta, Madras, Poona, and Singapore, and in the islands of Java and Ceylon; and through the kindness of my friends, the late lamented General Hardwicke, Colonels Sykes and Whitehill, Captains Law, Smee, and Smith, having access to their rich and extensive collections from Nepal, Bombay, and the Deccan; I may be enabled, perhaps, from such a mass of materials, to offer some new facts respecting the geographical distribution of Insects, a subject apparently little studied, and certainly not sufficiently appreciated. It is, indeed, with diffidence that I undertake a task beset on all sides with difficulties; and before I enter on it, I claim the indulgence of my readers, and solicit them to regard the present attempt merely as an outline sketch, which can afterwards be filled up with greater accuracy, as our acquaintance with the nature of the soil, and the forms of animal and vegetable life belonging to the East, become better known. The entomological character of a country is particularly influenced by three things; first, by its temperature; secondly, by its vegetation; and, lastly, by its soil; and, perhaps, a few remarks on these subjects (relating chiefly to the Eastern world) may not here be deemed out of place, before entering more fully into the entomology of the Himalayas and of India.

* The Author has to apologize to the Rev. Mr. Hope and to his readers for the long delay which has occurred in the publishing of this valuable Paper, written for him in 1834, and which has been in type for a considerable time. The Insects of the Author's collection which Mr. Hope has described, were collected in the neighbourhood of Saharunpore, in the valleys of the Himalayas, and on the mountains in the neighbourhood of Mussooree, at 6,500 feet of an elevation in 30° of N. latitude. The reader will observe that many of the desiderata required by Mr. H. on temperature and vegetation, are detailed throughout the "Illustrations," and he cannot fail to be struck with the remarkable coincidence in opinion, respecting the distribution of Insects as given by Mr. Hope, with that of the Author on the geographical distribution of the Flora of the plains and mountains of India.—J. F. R.

INFLUENCE OF TEMPERATURE AND OF MOISTURE.

In those regions of the world where we find a multiplicity of genera of animals, united with a prolificness of species, we may naturally imagine that circumstances are admirably suited to their existence; and, on the contrary, where we find a small number of genera, and in many instances a diminutive form, and a paucity of individuals, we arrive at an opposite conclusion. Now, if we search for the cause of these discrepancies, we shall find it to depend in a great measure on the influence of temperature. Let us examine, then, in what portion of the globe a super-fecundity of organized life exists. Certainly not at the poles, or even in the temperate zones; to the tropical and equatorial regions we must next proceed, and it is there, in those warmer districts of the earth that we find the energies of life more early developed, and vigour and productiveness seem the characteristics of the clime. These remarks apply not less to animal than to vegetable life, for no where do the Herbivora abound more than in warm regions, and no where do we meet with more luxuriance of foliage, or a greater exuberance of arboreous vegetation, than within the tropics. As we recede from the equator, and approximate to the poles, temperature gradually diminishes; and probably nearly in the same proportion as heat decreases, so shall we find the decrease of animal and vegetable species, till we arrive at that degree of cold where vegetation is stunted, circulation languid, animation becomes suspended, and existence is scarcely tenable, if not actually destroyed.

To obviate the effects occasioned by a low temperature, some animals burrow in the earth, and pass the winter in inactivity and torpor; others again, gifted with extraordinary locomotive powers, migrate into milder regions in quest of food, which the rigour of a brumal season and a northern climate has rendered precarious. It appears to me an observation worthy of attention, that at the very period the migratory birds visit us, Insects are already teeming into life, while vegetation has arrived at a state of forwardness sufficient to support, as it were, the expected increase of animal beings. We infer, then, that as vegetation is apparently regulated and influenced by temperature, so animalization is in a measure dependent on vegetation as a secondary cause. It may naturally be expected, in a gigantic country like India, whose superficial area is nearly one million and a half of miles in extent, that great diversities of climate will be found; and when we take into our consideration the altitude of its mountains, surpassing in grandeur the Andes of the American world, we may expect every gradation of temperature which can occur, from the intense cold of the eternally snow-capped height, to the baneful heat of the tropical valley. The elevation of the land above the ocean, the

height and direction of its mountain ranges promoting or checking radiation, its mighty rivers and interminable jungles, its soil, strata, and arid deserts, absorbing and radiating heat, exert their varied influences, and modify the temperature of that extensive Continent; and yet, admitting thus much, I cannot help stating an opinion, that according to the extent of the country, no other portion of the globe enjoys a more general and equable uniformity of temperature than India. This may satisfactorily be proved, provided we take as the basis of our argument the wide range of region, over which not individual species, but whole genera of Insects extend, and the general uniformity of Oriental vegetation. Before dismissing the important subject of temperature, I wish to offer a few remarks on the variation of heat and cold throughout the summers and winters in the Himalayas and in India. In the former Dr. Royle states, in his admirable pages, that the Flora of the Himalayas in the spring and summer of the year resembles that of Europe, while in the rainy season it becomes intermixed with tropic-like vegetation; and hence there is a certain admixture of genera belonging to temperate and tropical climes. The change of temperature and of moisture producing a new vegetation, exercises a corresponding influence over the distribution of Insects throughout the same country; and consequently we have reason to expect, as will afterwards appear in my remarks, that its entomological character is also twofold, uniting in itself that of both zones. This intermingling of genera of tropical and temperate regions will ever probably be found more perceptible in the rainy season, in advancing from the valley to the mountain height; and perhaps we ought to know the results of the following researches, before we attempt to arrive at any conclusion respecting the distribution of animal groups in the Himalayas or in India. I would therefore suggest to future travellers in these magnificent regions, first, to endeavour to ascertain the differences of climate, and the causes which affect its temperature; secondly, to find out the average limit to which tropical forms extend, to state where they most abound, where begin to lessen, and finally terminate; thirdly, to note in what proportions the genera of tropical and temperate climes are intermingled; fourthly, at what altitude temperate forms predominate over tropical; and, lastly, to mention as nearly as it is possible the range of any group of animals in preference to that of any individual species: both objects, however, are desirable. In addition to the above desiderata, it will be necessary to note the seasons of Insects and times of their appearance, the soil in which they are found, and the vegetation upon which they live; since the distribution of animals in general is greatly dependent on food, which food will abound,

or be found deficient, according to the richness or poverty of the soil, or according as the degrees of heat and moisture influence the same. It appears to me, that it is chiefly in swamps, and in low and marshy lands acted on by the rays of the sun, where there is a union of heat and moisture, that the major part of Insects seem particularly to flourish. In such localities we find genera more abundant, a great increase of species, the number of individuals prodigiously augmented, and the energies of life more rapidly developed. Animals appear more than usually productive, either in the alluvium of mighty rivers, or in the tropical jungle. It was on the banks of the Nile, amid its slime, acted on by the influence of the sun, that the doctrine of spontaneous generation originated, and I am told also entertained by the ancient Brahmans on the banks of the Ganges, as seen in Susruta. It is in like situations, where heat and moisture predominate, that nature still exhibits her surpassing and inexhaustible fecundity.

If we next turn our attention to the tropical jungle, we meet there with nearly an equally teeming exuberance and productiveness of species. The heavy tropical rains saturating the accumulated mass of heated leaves, and vegetable matter, considerable vapour is produced peculiarly adapted to increase insect life; and it is not a little singular, that as soon as the first showers fall in these regions, all nature becomes reanimate; and as the rains increase, so do the Insects in proportion more and more, till the rainy season fairly sets in, at which period the jungle and the forest literally teem with myriads of insect population, more numerous than the stars of heaven, and as countless as the sands of the sea-shore. In concluding this part of my subject, I need only repeat shortly, that heat and moisture combined, exercise a powerful control over the geographical distribution of insect life, and that this distribution is also influenced in a greater or less degree by vegetation, as well as by the soil of a country; but these are subjects which require further elucidation.

INFLUENCE OF VEGETATION.

The entomologist who wishes for accurate information respecting the geographical distribution of Insects over the wide extent of our globe, must take into his consideration not only the influence of temperature, but that of vegetation; nor should he omit to note the varieties of soil which materially influence it. The dependence of this distribution of animals, although greatly swayed by temperature, is no less so by the supply of food and nourishment they can obtain. Insects are designated according to the kind of food they consume, as carnivorous or phy-

tyvorous; and in proportion as food is ample or deficient, so probably they abound in numbers, or decrease and vary in magnitude and form. To its abundance we may in some measure attribute size, to its deficiency the frequency of dwarfishness of stature, immaturity, and many of the numerous crippled specimens, as also some of the monstrosities found in our collections. The great Latreille has justly observed, that where the empire of Flora ends, there also terminates that of Zoology; and I have little doubt, that where vegetation is richest, there animal groups also will be found most abundant in genera, species, and individuals, not only those which are herbivorous, but those also which are carnivorous.

It is not my intention here to enter into any details respecting the Himalayan or Indian Flora. If the reader requires information on these points, I refer him at once to the accurate and invaluable pages of Dr. Wallich and Dr. Royle; and as I at present look merely to the vegetation, as influencing in a great measure the character of the entomology of the country, a concise outline of the leading features of the Botany of those regions is all that is here requisite. Throughout India, according to the above authorities, there appears to be an uniformity of vegetation, tropical species greatly predominating over those of the temperate zones; there occurs also a considerable admixture of genera belonging to temperate climes, and at a high elevation plants abound, which are indicative of Alpine regions. Several genera appear common to Europe, North America, and India; and in some instances identical species have been recognized as existing in Europe and in Asia, as well as in the New World. It still remains, however, with the botanist to determine the similarity of vegetation in Western India and Africa, a similarity which I anticipate will be eventually found to exist, if not at present actually known—a similarity I am led to suspect solely from observing a great resemblance in the character of the entomology of Western India and Eastern Africa.* In many instances cognate species of Insects appear both in Africa and Asia, which, by a careless observer, might be considered only as varieties; they are, however, on examination, sufficiently distinct, and I therefore think myself justified in esteeming them the representatives of their respective countries, as undoubtedly they fulfil the same offices and functions in both. In several cases we meet with identity of species in Asia and Africa; and there is an observation

* Vide p. 159 of the "Illustrations," where the similarity of vegetation in parts of India and in Western Africa is referred to, as originally remarked by Mr. Brown, and which has been confirmed by subsequent discoveries.—J. F. R.

I have made, worthy of still further investigation, that most of the Insects which are identical in both countries, are either coprophagous or phytyphagous; in short, vegetable feeders, which circumstance would lead one to suppose a similarity of vegetation in the different regions.

It may here be expected, perhaps, that I should state the relative proportions of the carnivorous and phytyvorous Insects; and I cannot but regret that I have not as yet followed up my investigations sufficiently to enable me to draw a satisfactory conclusion. Messrs. Kirby and Spence, in their interesting work, speaking of our British Fauna, esteem these groups as nearly equal in number. I must confess my own observation induces me to believe, that the latter greatly exceed the former in our own country. With respect to the phytyvorous group in tropical climates, they certainly greatly out-number the carnivorous; and were it not so, the air in those regions would scarcely be habitable, considering the nauseating effluvia arising from excrementous matter, which the Copridæ in particular tend to neutralise, by consuming, decomposing, and burying in the earth, all that is obnoxious and liable to putrify. In proof of this assertion, I will only here add, that five of the greatest groups with which we are acquainted, namely, the Lamellicornes, the Sternoxes, and the Longicornes, the Curculionidæ and Chrysomelidæ, are almost entirely phytyvorous or xylobious; and it may also be naturally inferred from the superabundance of animal life of all classes within the tropics, particularly the Ruminantia, that there also vegetation will be found most luxuriant; yet, looking to Insects only, we find they are scarcely sufficient to keep in check its excessive exuberance. In addition to multiplied forms of genera, we have an extraordinary increase of species and of individuals. It is in these same prolific regions also, that the mighty Goliathi and gigantic Prionidæ abound, where they perforate the trunks of the proudest monarchs of the forest, and hasten them onward to decay; and, by means apparently inefficient, check vegetation. It is time, however, to add a remark on the carnivorous Insects, which, although inferior in numbers to the phytyvorous, are still an important group; and in northern regions, by removing the decomposing matter from the decaying and putrifying carcass, fulfil the functions assigned to them by Providence. In tropical regions they are certainly not always so abundant, as a dead body, from the natural dryness of the air, and intense heat of the sun, is frequently dried up before putridity has made much progress; at least, such is the case in the Pampas. I cannot help thinking, however, although our cabinets contain but few species from equinoctial and tropical latitudes, that eventually they will be found more numerous, and that in these regions we shall still find them more proportioned to the excess of animal

life than appears to be the case at present. Religious prejudice, and the filthy and disgusting habits of these Insects, may be the causes why they have been neglected. In India, if the Necrophaga are not so numerous as elsewhere, yet the numbers of some particular species being excessive beyond measure, are sufficient, perhaps, to compensate for want of variety.

RANGE.

In the consideration of the geographical distribution of Insects, especial notice should be taken of the range over which genera and families extend. From want of attention to this subject, entomologists have not sufficient data to form any just views respecting it. Every naturalist who has studied animals, must be aware that certain tribes, genera, and species, are peculiar to particular regions of the globe. On the contrary, in various countries of the earth the Botanist meets with genera of plants which are common to Europe, and the other quarters of the globe, to the Old World as well as to the New. In some instances, identity of species has been recognized in countries remotely situated, between which seas and oceans intervene. It becomes, then, a question of considerable importance to determine if any species of plants have an unlimited or universal range, as probably all those insect races which feed on vegetables are regulated in their distribution by the same laws which govern the distribution of the plants themselves. It must be evident even to the most careless observer, that where the climate is materially changed in temperature, that there vegetation will be proportionately altered, and I imagine that eventually the entomological character of a country will be found much more dependent upon vegetation than has hitherto been allowed. It is true, indeed, that although two countries may agree in temperature and botanical character, the Insects may be totally different in form and appearance; but, in looking to their functions, if we find them the same, or nearly the same, we at once acknowledge the resemblance, and imagine they take the place of other known and existing groups elsewhere; a resemblance of character, which Messrs. Kirby and Spence have very properly denominated representation, which representation will even be more perceptible as the soil and general characters of the countries accord.

INFLUENCE OF SOIL.

Having already seen that both temperature and vegetation exercise a powerful control over the geographical distribution of insect races, there still remains a third subject of inquiry, namely, the influence of

soil over the same groups. If we find that in particular rich soils various genera of Insects abound, and that in others of an inferior quality scarcely a species can be met with, may we not naturally infer that there must be some peculiarity in it, and that the animal groups are influenced by their attachment to the same? The Botanist readily admits that vegetation is materially influenced by it, but as yet the Zoologist has made little inquiry respecting this subject, replete as it ever must be with high interest, and well worth most serious attention. Without entering deeply into the geology of India, I may state, on the authority of Colonel Sykes, that the character of the geology of great part of the Peninsula, like that of its vegetation, presents considerable uniformity: unacquainted with its leading features, I can derive my observations respecting it solely from the examination of the genera before me. I will, therefore, merely give concisely what groups attach themselves to particular soils in different countries, and hope that the attempt, imperfect as it is, may induce other naturalists to undertake an inquiry which must lead to very important results. As the mountain, the valley, and the plain, have their own peculiar temperature, vegetation, and soil, they have also particular groups of animals attached to them; and if we look more closely, we shall find that particular families and genera are always to be met with in certain strata and soils, evincing, as it were, a partiality and adaptation, by frequenting and thriving in them.

It may here be worth while to specify some of the genera of Insects attendant on the difference of soil. It is in the sandy districts of our own country that the few species of Cicindela, peculiar to our island, occur. Cicindela maritima, however, prefers the vicinity of the sea-shore, while several Oriental species, remarkable for their beauty and colouring, delight more in the alluvial soil of rivers Frequenting the sandy heath are found the splendid Chlorion, the fetid Sphex, and restless Ammophilus, associated with numerous species of Andrena and Nomada. In the sand, washed from the mountain height, at the sources of our European rivers, some species of Nebria and Psammodius are exceedingly abundant. If we visit the parched and burning sands of Africa, we there meet with the rapacious Anthia, the desert-loving Graphiptera, the burrowing Scarites, and countless species of Heteromera and Tetramera. In the same soil also, on the banks of rivers, the genera Epaphius and Trechus, Clivina and Dyschirius, are not unfrequent. On the sand of the sea-shore, Broschus, Bradytus, Pedinus, and Ægialia, occur in extraordinary numbers; and where it is habitually covered with salt water at the departure of the tide, we capture Cillenum, Pogonus, Hesperophilus, and Heterocerus, the singularly-formed Bledius, and wonderfully-abundant Ophonus

pubescens, all of which I have reason to believe can live submerged beneath the sea a considerable period. Of all other soils, *clay*,* being naturally cold, attracts fewer Insects, excepting the widely-disseminated Harpali. In gravel, occur the genera Opatrum, Halictus, Cerceris, with numerous colonies of Ants. To a chalky soil are attached the Ophoni, Licini, Chœtophora, and various species of Polyommata, Osmia spinulosa, and Andrena hæmorrhoidalis. When collecting in the mud of the fresh-water marsh, we capture Blethisa, Chlænius, Omaseus, and Agonum, and several Carabidæ. In the slime of brackish waters, several Notaphi are exceedingly abundant, though rare elsewhere; and in company with them we find the subaquatics Elophorus, Parnus, and springing Salda. It has also been observed, that Pimelia is only to be met with where the plants of the genus Salsola abound. Catascopus and Elaphrus frequent the alluvium of rivers. In the mud of lakes and pools various genera of Eupodina, Nothiophilus, Bembidiadæ, and Trechidæ occur; and in vegetable mould, where the grass is luxuriant, numerous Diptera, and Larvæ of Lepidoptera, abound. Even in this short and imperfect account of different genera attached to varieties of soil, sufficient has already been stated to prove that it exerts an important control over the range and distribution of Insect races: however, to give the naturalist a better insight into Indian groups, I shall here add an analysis of the leading families and genera which have fallen under my observation, and then conclude with an abstract describing the leading characters of Himalayan and Indian Entomology.

From what has already been written, it will appear that Insects, in their geographical distribution, are influenced by various causes; by temperature, by excess or deficiency of moisture, by the influence of vegetation, and by soil. There is yet, however, another, which materially affects, in some instances, particular groups, namely, the peculiarity of the organization of the Insects themselves. Should any genera of Insects occur which are deficient in the organs of locomotion, they would naturally be restricted to certain localities. How many genera of the Coleoptera and other orders are apterous, and are only found in particular situations; and they have necessarily particular functions to perform in their restricted limits, and also particular organs adapted to the work assigned them by the Creator. It is to the study then of the differences of organization adapted to differences of situation, and other external circumstances wherever we find Insects, that the entomologist should

* Mr. Shuckhard informs me, that Andrena labialis seems peculiarly attached to the London clay.

direct his attention. Contemplating all these instances of adaptation, we reverence the wisdom of a creative and the beneficence of a superintending Providence, that prevents diminution and increase, both extremes of which would prove injurious; for without these "armies of the living God," to keep in check the fecundity of nature, plague and pestilence would walk abroad, and depopulate not a single country, or one quarter of the globe, but the whole earth itself.*

ANALYSIS

Of the ENTOMOLOGY of the HIMALAYAS and of INDIA.

CICINDELIDÆ.

The following genera belonging to this family are not uncommon in India, *viz.* Therates, Tricondyla, and Colliuris: the two former are characteristic of a southern range, while the latter is abundant throughout the eastern continent. Of Indian Cicindelidæ, more than sixty species have fallen under my notice: the most splendid of the race abound in Nepal. Among various species, however, peculiar to the Himalayas, only one approaches the form of our European Germanica.

DRYPTIDÆ.

As I am only acquainted with a single species of Indian Casnonia, I pass on to Drypta, a Nepalese individual of this family belonging to the genus Desera, Leach, which is described in General Hardwicke's collection. Five others are also recorded as inhabiting India.

LEBIADÆ.

Cymindis has not yet been discovered in India; eventually it may occur in the Himalayas: it is difficult to imagine what genus takes its place. Lebia is of rare occurrence in the East; a non-descript, named unicolor, in my collection, is from the Himalayas. Aploa is found at Poona. Orthogonius is common to Africa and Asia: the gigantic species, however, predominate in the latter country.

* In concluding my observations on the geographical distribution of Insects, I think it may be stated, that naturalists on this subject have almost exclusively directed their attention to temperature. Where temperature fails, we may turn to vegetation; and if the latter is not sufficient, then to the soil and strata of a country, and even to the organization of the Insects themselves, as well as other causes. No one by itself is sufficient to unravel the difficulties which arise; by uniting all, however, we may in a great measure account for the various discrepancies that occur.

BRACHINIDÆ.

The French writers appear unacquainted with the true type of Helluo, exclusively belonging to New Holland: the genus denominated Omphra by Dr. Leach, applies solely to the Indian Helluones. Ozæna and Pseudo-zæna inhabit Calcutta and Cayenne; while Trigonodactyla appears in Africa and Asia. The Graphipteræ of the sandy deserts have no representative in the East. This genus appears to unite Brachinus and Anthia: the latter is found throughout the continent of India. Some of the specimens from Nepal, however, are very diminutive. Aptinus is partly confined to Northern Europe and America; while true Brachinus enjoys the unlimited range of the world. Catascopus is found in Nepal, and resembles in its habits Elaphrus of Europe, and probably occupies its place. Dyscolus, Promecoptera, and Thyreopterus, prefer the southern tropical regions, and are not found to range as far north as the Himalayas.

SCRAITIDÆ.

Siagona atrata is met with in Nepal and various parts of India: a specimen lately received from Egypt, if not the self-same, is so exceedingly alike in size and sculpture, that it is very difficult to distinguish. The Scaritidæ abound in both hemispheres. Scapterus of India is represented by Oxystomus in the Brazils, and in Africa by Acanthoscelis. Morio and Clivina will, perhaps, be found in both the Old and New World; the latter, indeed, is common to all temperatures; the former may eventually occur in Europe, perhaps in Sicily.

HARPALIDÆ.

Harpali are found dispersed nearly in all the countries of the globe: they abound more in the arctic than antarctic regions. The following genera are recorded as belonging to India, *viz.* Harpalus, Platymetopus, Selenophorus, Cyclosomus, and many others. Some species of Ophonus from Bengal and Poona, closely resemble British species.

POGONIDÆ.

Some of the genera of this family are not confined to the temperate zones; the major part of them prefer the polar regions. Pogonus and Cardiaderus are met with in Asia and Africa; while Patrobus is apparently peculiar to Northern Europe and America.

CALATHIDÆ.

Dolichus has not yet been discovered in India: it is probable, how-

ever, that it will occur there. Pristonychus inhabits Nepal and Europe; while Calathus prefers a northern more than a southern climate.

FERONIADÆ.

Instead of finding Pœcilus in India, we meet with Trigonotoma, Catadromus, Lesticus, and Distrigus: most of them peculiar to that continent. Argutor antiqua occurs in the East; Omaseus and Platysma in Nepal; and Steropus in the vicinity of Poona. It is by mistake that Percus has been introduced among oriental genera. Cephalotes is found in Nepal and Australia: Stomis, Zabrus, and Pelorus prefer the temperature of Southern Europe. They may, however, be expected to appear in the Himalayas. Amara is captured in Japan; Antarctia and Masoreus are equally natives of Europe, Africa and Asia. Several nondescript species from the East, of the latter genus, are to be found in our English cabinets.

SPHODRIDÆ.

The genus Sphodrus occurs in Nepal, and the anomalous form of Mormolyce in Java and Singapore; which last has been ranged with this family, but appears to be sadly out of place, as it is most likely a subcortical feeder.

ANCHOMENIDÆ.

I am not aware that Platynus, Agonum, or Olistophus, have yet been discovered in India: the two former will no doubt be found in the Himalayas, when the Insects of that country are better known.

CALLISTIDÆ.

Epomis and Chlænius abound in the tropics: the maculated set appear common to Asia and Africa, each country possessing species almost exact representatives of each other. Chlænius nepalensis approaches in form to Licinus; and although Oodes is widely dispersed over India, no Nepalese examples have yet come under my notice. Callistus occurs in the Mysore.

DICŒLIDÆ.

Rembus is found on the Malabar and Coromandal coasts, at Calcutta, and in Nepal: its allied genus, Licinus, may be expected to occur, as some Asiatic species have already been described. Panagæus has its metropolis in India.

PROCERIDÆ.

Among the Insects collected by Dr. Wallich, there were four or five

species of true Carabus, only one of which I was enabled to describe. Several may occur in the colder mountain temperature, and it is probable they will resemble Siberian forms. Wherever the oak grows, there Calosoma will be found. Seven eastern species are known to me. C. indicum inhabits Nepal. If caterpillars are necessary to keep in check the luxuriance of tropical vegetation, surely the Calosomata are equally necessary to keep within bounds these Insects, which sometimes destroy, in northern climes, nearly the foliage of the year.

NEBRIADÆ.

This family may be considered as belonging to a Northern and Alpine range. Should it occur in Nepal, it will be found at a considerable elevation, possibly amid the Himalayan snows. As to Elaphrus, I have already stated an opinion that Catascopus represents it in India.

BEMBIDIIDÆ AND TRECHIDÆ.

Of the former family, several genera will no doubt eventually be found in Nepal: a single species of Tachys is the only example I am able to record at present. Of the latter, Stenolophus, Acupalpus and Tetragonoderus have occurred: the last of which may take the place of Bembidium.

DYTICIDÆ.

Aquatic Coleoptera are apparently not much influenced by climate: the temperature of water not varying like that of the earth or air, is the reason we meet with the self-same species in the interior of India and the south of France. Dyticus appears confined to Northern Europe or America, while Cybister is dispersed throughout the world. Eunectes and Hydaitcus belong to Nepal and India, and to the latter country we may add also the following genera, *viz.* Colymbetes, Laccophilus, Noterus, Hyphydrus and Hydroporus.

GYRINIDÆ.

Many gigantic species of Gyrinidæ abound in India. Dineutus nepalensis, politus, and spinosus, have been found within the Himalayan districts.

HYDROPHILIDÆ.

Several genera of this family are as widely distributed as the Dyticidæ; and most of those found in India inhabit Nepal.

NECROPHAGA.

Differing with most entomologists, I am inclined to believe that the carrion feeders abound more in warm countries than is generally believed.

The religious prejudices of the Indians not allowing them to touch a dead body, may account for the few species which have hitherto reached Europe from the East. Necrophorus, Necrodes, Silpha, and Oiceoptoma, are met with in India and Nepal. It is probable that Necrophorus is more peculiarly adapted to Northern climates, while the remaining genera affect those of tropical regions.

EROTYLIDÆ.

Passing Nitidulidæ, which have been captured in India, we arrive at Engidæ and Erotylidæ. In the former family, we find Triplax, Ips, and Dacne; in the latter, Erotylus; and next to this group, Languiria and Eumorphus should be placed; genera abounding in species in Nepal and India.

DERMESTIDÆ.

In General Hardwicke's Collection, there is a Nepalese specimen of Dermestes, similar in every respect to D. lardarius of Europe: a second species is closely allied to D. vulpinus of Africa. It is scarcely possible that either of them can have been imported into the Himalayas by commerce. This genus, and its congeners, is apparently a predominant group throughout the world.

BYRRHIDÆ.

The foreign Helocerata require attentive examination. Among the drawings of the Nepal Collection, made purposely for General Hardwicke, two species of Anthrenus are figured: they appear novel in form.

HISTERIDÆ.

This family abounds in India. I am acquainted with more than fifty species from the East: some of the Nepalese specimens are in too mutilated a state to describe.

LUCANIDÆ.

I formerly described six species from Nepal: two more from the Himalayas are undescribed in Dr. Royle's Collection. In no country is there a greater admixture of temperate and tropical forms than in India; some of the Lucanidæ resemble our British species very closely, while others are the same as those in Java and Singapore. Forty species have been submitted to my inspection. Passalidæ are not equally abundant in the Old as in the New World.

LAMELLICORNES.

The celebrated Ateuchus Ægyptiorum, or Sacred Beetle, has al-

most an exact representative in India. Gymnopleurus capicola, Hope, and azureus, Jab. both of them African species, are replaced in the East by G. sinuatus, Jab. and splendens, Hope. Sisyphus is met with in both hemispheres. Epirinus is an African, as well as an oriental form. Several Indian Copridæ resemble those of Egypt. Copris Midas of India and Nepal, exactly corresponds with C. Isidis of Africa. C. Sabæus and Pithecius appear common to both continents, and are equally abundant in Ceylon; and several smaller species of Copris, from the eastern part of Africa, if not the same, approach so closely to those of Western Asia, as to induce a belief that they are the same Insects, only modified by climate. Onitis and Oniticellus have also several representatives in both regions, if not in some instances the self-same species. Onthophagus abounds more in India than any other country; some of them unrivalled in size, splendour, and variety of form. More than 120 oriental species may be seen in European cabinets; five only now are described from Nepal; double that number, however, are in too mutilated a state to be characterized. Pactolus of Nepal and India, is represented in Senegal by Harpax, Jab. Aphodius, compared with Onthophagus, as an Indian group, is quite insignificant; scarcely twenty species are recorded, including those of Manilla and the Eastern Isles: a non-descript from Nepal will appear in the Appendix. As there is only a single specimen of Trox in General Hardwicke's collection, I pass on to

GEOTRUPIDÆ.

Geotrupes has been denied by Latreille to exist in India; the Baron de Jean also makes no mention of any Eastern species from that country in his last catalogue. Two species are in my recollection; one from Delhi, and a second from Japan; a third also, unique, is among Dr. Royle's Insects from the Himalayas. It is probable that this genus, when found in India, appears on mountains at a considerable elevation: the species also may be the common food of the Shrikes of that country, as they are in Europe, should those birds be found there. Orphnus, Athyreus, and Hybosorus, occur in India. Bolboceas appears in some measure to supply the place of Geotrupes, which last is not so important a group in the East, as in a northern region.

SCARABÆUS.

Under this term, the gigantic and most remarkable Insects of the Old World are ranged. Four species, allied to S. Atlas, Jab. are indigenous to Nepal, a convincing proof that equatorial forms extend beyond the

tropics, and that they are found in much colder temperature than is generally believed. There are several genera of Scarabæidæ, besides Oryctes, found on the Himalayas, as yet uncharacterized; some of them approaching African types.

MELOLONTHIDÆ.

Some of the Melolonthæ of Nepal are closely allied to our British M. vulgaris; others again, with the margins of the thorax serrated, evince their affinity to tropical species. Geniates, Apogonia, &c. are common to the Himalayas, the whole continent of India, and the Southern Isles.

MIMELÆ and EUCHLORA.

These genera appear peculiar to the East: in a monograph, read before the Entomological Society, there are thirteen Mimelæ described; several from Nepal. Euchlora appears wherever Mimela ranges, and is more abundant in species.

POPILLIA.

This genus appears nearly equally abundant in Asia and Africa, and is common to the Old and New World. Fourteen species have been collected in Nepal. The following genera of Melolonthidæ, also, *viz.* Anomala, Hoplia, Apogonia, and Adoretus, occur in the same territories.

TRICHIIDÆ.

Acanthurus, Trichius, and Dicronocephalus, inhabit the Himalayas. The first of these forms approaches our European type, the latter is the representative in India of what Goliathus is in Africa, and Incas in Southern America. Goliatidæ is a conspicuous family, and may justly be ranked among the most extraordinary forms of the Insect world.

CETONIADÆ.

Although I described seventeen species from Nepal, Dr. Royle's collection appears to contain at least six more, entirely new. Campsiura xanthorhina, Hope, is represented in Africa by Cetonia scutellata, Jab. C. cornuta, Jab. is found in Africa, as well as Asia. I am acquainted with more than 111 species from India, and from this surprising number still likely to be greatly increased, it is evident that the metropolis of Cetoniadæ is situated in the tropical regions.

BUPRESTIDÆ.

Of this superb and extensive family, comprising at present more than one thousand species, existing in the cabinets of Europe, the most magnificent inhabit India; the splendid Sternocera and giant Catoxantha

range the Equator and the Tropics. Ninety species belong to the continent of India, many to Nepal, the isles of Java and Sumatra: among them are forms of temperate as well as of northern climes.

ELATERIDÆ.

This family persents us with types of form belonging both to the tropical and temperate regions: the former, however, are few in number, when compared with the latter. Several of the Nepalese Elateridæ resemble our British species, some so closely as to induce one to imagine that difference of climate is the cause of variety of the species. Elater murinus, Fab. of England, is well represented in Nepal by Elater cœnosus, *Hope*; and various species, which in Europe frequent the oak, alder, and willow, have Nepalese species nearly resembling them, and we have stated that there is a correspondence of vegetation between Europe and the Himalayas.

LAMPYRIDÆ.

Passing the Cebrionidæ, few examples of which occur in India, we arrive at the Lampyridæ; and justly may the East boast of its numerous and fine species, unsurpassed probably by those of South America. The warm damp of the jungle is peculiarly adapted to the habits of this family. Lycus and Omalysus, as well as Lampyris, abound in the Himalayan range.

MALACODERMATA.

By some writers, the families composing this group are considered rare within the Tropics, and they certainly are more abundant in Nepal than Central India; and yet they are not of rare occurrence. Anisotelus, Hope, appears to be peculiar to the East. Several species of Malachius and Melyris enjoy an Asiatic and African clime.

CLERIDÆ.

By the family Cleridæ abounding in the East, we arrive at the Ptinidæ; they, the latter probably, exist in Nepal; none, however, I believe, have yet been discovered in India, the nearest locality where they are found being the Mauritius. The Bostrichidæ are, however, abundant, and it is not unlikely that the Paussidæ commence where the Ptinidæ terminate.

CURCULIONIDÆ.

Without entering at large into the geographical range of the numerous genera of this family, I briefly state, that Nepal contains many tropical

forms, as well as others, which are peculiar to temperate climes, some of them extending from the Himalayas, even to New Holland, particularly Sipalus.

PRIONIDÆ.

By the Cucujidæ (common to India and Nepal) we arrive at the Longicornes. Prionus loves the torrid and tropical zones; some of the Himalayan species indicate an alliance to European types.

LAMIADÆ.

The largest, as well as the most beautiful species of this family, are found in Nepal. Lamia Roylii, Hope, is unrivalled in size; and L. Wallichii surpasses all others in beauty and colouring; it is found in Nepal, Japan, at Singapore, and the Isle of Java. Cerambyx, Callidium, Clytus, and Saperda, are predominant groups, and are found in all countries and climates. Many Nepalese species exactly represent our European types.

SAGRIDÆ.

Omitting Lepturidæ, confined almost entirely to Northern Europe and America, we arrive at Sagridæ. Donacia occurs in Java, and we may expect to meet with it in Nepal, and other parts of India; if not, it is probable that Sagra takes the place which Donacia does in northern regions. Several species of this genus are found on the Nympheacæ. I am doubtful if Sagra attaches itself to peculiar water-plants, or frequents the same as the former genus. Megalopus is found in Nepal, in Africa, as well as South America. Crioceris also appears to be a predominant group, while Adorium is confined more to Asia than Africa.

GALLERUCIDÆ.

Galleruca and Auchenia abound in Nepal, Halticæ are found throughout the world, and are intended probably to keep in check particular vegetation. In Europe, the genera Brassica and Sinapis almost annually suffer from their depredations; they appear to abound more in light and sandy soils; and where lime is used instead of animal manure, the crops are less attacked.

CHRYSOMELIDÆ.

Many of the Nepalese species resemble those of Siberia; others approximate closely to our European forms, so much so, that in many instances they appear like one and the self-same Insect; and if not the same, they are certainly similar representatives of their respective coun-

tries, and probably fulfil the same offices and functions. Podontia and Phyllocharis seem peculiar to Asia and New Holland.

EUMOLPIDÆ.

The Eumolpidæ of India are not surpassed in beauty or splendour by those of South America: they seldom, however, equal the latter in size. Clythra and Cryptocephalus occur in the East, both of them abounding more in temperate than tropical countries; in Dr. Royle's collection there are found several undescribed species from the Himalayas.

CASSIDIDÆ.

About fifty species of Indian Cassida have come under my notice; some of the Nepalese species resemble our English specimens, and may be parasitic on the thistle, as they are with us.

COCCINELLIDÆ.

Although I described twenty new species from General Hardwicke's collection of Nepal Insects, I find five others undescribed in Dr. Royle's collection from the Himalayas. Coccinella 7-puncata, Fab., appears common to Europe and Asia; at least the specimens agree so exactly in every respect, that after a very accurate examination, no important difference can be found; and believing them to be the same, I still cannot imagine that they have been imported into India by commerce. Endomychus may eventually be expected to occur in Nepal.

HISPIDÆ.

Hispa erinacea is abundant in Nepal; and two undescribed species are in Dr. Royle's collection from the same country.

TENEBRIONIDÆ.

The transition from Hispidæ to the present family by means of Sarrotrium is rendered easy. Hegeter and Tagenia, common to India, appear to follow in successive order. Both Upis and Tenebris are found in the Himalayas, and are abundant in the Tropics.

PIMELIARIÆ.

Pimelia has not yet been described as existing in India; last year I received two species from the vicinity of Poona. Sepidium, Blaps, Eurynotus, and Opatrum, occur in the East; the first prefers the Southern Tropic; the two next appear at Bombay, Calcutta, and Nepal; and the last is widely dispersed throughout the East. Passing Diaperidæ and

Cossyphus, both of them common to Asia and Africa, we next meet with Cistela and Lagria: the latter apparently a predominant group. Pyrochroa, also, has been discovered in Java.

HELOPIDÆ.

This family is the grand receptacle for the various forms of Heteromera. Among the Indian genera we find Amarygmus, Cnodulon, and Platycrepis, with several true Helopidæ, rivalling in splendour and magnitude those of the South American Continent.

MORDELLIDÆ.

Most of these Insects are parasites of the Hymenoptera, and abound in tropical climates. Their office is probably to keep in check, and prevent the too rapid increase of Vespidæ and Bombidæ: they are common to the Old and New World.

CANTHARIDÆ.

The geographical distribution of this family is particularly interesting, as it contains those Insects which are used in Medicine, and denominated Blister Flies. Lytta gigas, Fab., is found abundantly in India, and also in Senegal; and there is little doubt that several species of Mylabris will be found common to both continents. These vesicatory Insects of the Old World are replaced in the New by the genus Tetraonyx.

STAPHILINIDÆ.

By the families Notoxidæ and Scydmænidæ, we arrive at the Pselaphidæ, and afterwards at the Brachelytra, which terminate the Coleoptera. Anthilephila and Notoxus occur in Nepal, and Scydmænus in Java; while various other genera of Staphilinidæ are widely dispersed throughout the East.

ON THE REMAINING ORDERS.

Having entered fully into the consideration of Eastern Coleoptera, it is not my intention at present to go into lengthened details of the remaining Orders. It is sufficient to state, that in all of them there will be found similar and corresponding characters as in the Coléoptera. With regard to identity of species, I cannot help remarking, that of Lepidoptera, there appear to be a much greater number of species, widely disseminated throughout the world, than of any other Order. In Asia and Europe we meet with Papilio Machaon, Gonepteryx Rhamni; with some species of Colias and Pontia, with Vanessa Atalanta, and Cynthia Cardui; and to these might be added, several identical Sphingidæ, particularly Acherontia, Atropos, Deilephila, Celerio, and Sphynx. Among

the Noctuidæ, Geometridæ, Tortricidæ, and Tineidæ, many species will also be found inhabitants of both continents. In the Orthoptera, some Gryllidæ are common to countries remotely situated, which may partly be accounted for by the migratory habits of these Insects; and the same remarks may be applied to the Sphingidæ. Among the Blattidæ, several tropical species range widely; some of them have become naturalized even in a northern climate; and it is no uncommon occurrence to find Indian, Brazilian, and New Holland, species in a high state of perfection alive in the houses of London; and among the Eastern Neuroptera, there occur various Libellulinæ and Hemerobeidæ, closely resembling our English species.

Among the Hymenoptera, may be noticed the universal ranger, Evania appendigaster, ever attendant on Blatta; some Icheumonidæ, Crabronidæ, Apidæ, and Vespidæ, all of them presenting identical species with those of our own country. In referring to the Diptera, I need only mention the wide range of the Orange Fly, the same in England, India, and America; the Gnats and Mosquitoes, common to the four quarters of the globe, alike the pest of the Indian and Laplander; and, lastly, various species of Musca, as widely dispersed as the half-domesticated sparrow of Great Britain. Passing by the Aptera, and the various parasites of birds, quadrupeds, and of man himself, we shall find also among the Hemiptera, several identical species of Pentatoma, Reduvius, Tetyra, besides Cimez lectularius, the scourge of all countries and climates. It does appear, then, from the above Analysis, that Asia and Europe have many Insects in common, and probably other parts of the world will eventually be found to present not only similar genera and representatives, but also the same identical species, subject to the modifications of climate, and other external circumstances.

CHARACTER OF HIMALAYAN ENTOMOLOGY.

The character of Himalayan Entomology is twofold, Asiatic and European; and the intermingling of forms of temperate and tropical climes is one of its most distinguishing peculiarities. In its valleys (probably influenced by the heat and moisture of the jungle) southern forms predominate over northern; and it is not unlikely, that to the uninterrupted belts of jungle stretching along the mountain ranges, we may partly trace several tropical phytyvorous genera far beyond their apparent natural limits. Some carnivorous Insects are also found ranging far to the north in the Himalayas; an example of which is Anthia 6-guttata, a well-known

native of the Tropics : the specimens, however, are mere dwarfs, compared with those of Peninsular India, a fact which may be regarded as a proof, that Anthia has here reached its extreme limits, and consequently will soon disappear (as is the case) and be represented by another type, fulfilling the same functions, only under a difference of form. The following genera of Himalayan Insects, selected from many others, will evince their tropical relationship. Among the Cicindelidæ, Colliuris appears; among the Carabidæ, we find Desera, Omphra, and Cyclosomus; among the Lamellicornes, Euchlora, Mimela, and Dicronocephalus; and to these may be added, Anisotelus belonging to Telephoridæ, and Podontia and Phyllocharis to the Chrysomelidæ: all of them attached to warm countries, and some, indeed, are seldom found but within the Torrid Zone. It is needless to state many genera from the Himalayas evincing an affinity to European types;* some few, however, are worth noticing, such as Broschus and true Carabus, Geotrupes and Pimelia: the two last have been declared by high authority never to be found in India. Regarding identity of Insects occurring in the Himalayas, as well as in Europe, there are several species of the following genera of Coleoptera, namely, Elater, Melolontha, Chrysomela, Cassida, and Coccinella, which I cannot help thinking are the same as those of England; particularly as the vegetation of the two countries greatly coincide, for in very many cases, genera, and in some instances the self-same species of plants have been recognized. Among the carnivorous Insects, I believe that Dermestes lardarius, and vulpinus, Corynetes violaceus, and rufipes, and some of the Staphilinidæ, are essentially the same in Europe and the Himalayas. Of Lepidoptera, I figure Papilio Machaon, because it is evidently the same as what we meet with in England; the same remark will apply to Vanessa Atalanta, and Cynthia Cardui. The French entomologists are inclined to regard the Insects of widely separated countries as distinct species; I wish to esteem them as varieties, and I cannot help thinking, that as identity of Plants has been satisfactorily proved by Dr. Royle, so also we may believe in the identity of Insects in regions widely removed from each other. At any rate, should these varieties eventually prove distinct (which may be ascertained, I think, in the Lepidoptera order, when we become better acquainted with the oval, larval, and chrysalidous stages), yet the

* I may here add, that various Himalayan genera closely approximate Siberian forms, and that some of the species described by Dr. Gebler from the Altaic chain of mountains, particularly some Chrysomelidæ, I believe to be indigenous in both regions.

differences will ever be so slight, that we cannot separate or distinguish them in the imago state with any degree of certainty. But whether they be accounted species, or only varieties, we see the grand object of their creation, in their fitness for performing certain functions which are assigned them; one of these is, to keep in check the luxuriance of vegetation and to restrain it within due limits; another may be, that these puny agents may fecundate the flowers, by carrying the fertilizing pollen from tree to tree, and thus be the means, in one case, of promoting vegetation, as in another they are the agents of its destruction.

ENTOMOLOGICAL CHARACTER OF INDIA.

From the foregoing Analysis, I have no hesitation in asserting that the pervading character of Indian Entomology is uniformity. It is true that we meet with numerous genera, both of tropical and temperate climes, associated together; the former more abundant, the latter less frequent (as we might naturally expect) than in the Himayalas. There is, however, a greater intermingling of forms than at first sight would be readily imagined; but when we take into our consideration, that many of the species resembling those of Europe may have been captured on the mountain ranges, at a considerable elevation, we may partly account for it. This attempted explanation, however, is not always available or satisfactory; for in the heated valleys of the East, we find many European types and species, in numbers sufficient to excite our astonishment. It will appear, then, that many species taken in temperate and northern climes, are not confined to them, and that the range they enjoy is very considerable, extending not only over the Old World, but also to the New. As we advance from the Poles to the Equator, vegetation is more luxuriant, in proportion as heat increases, and the quantity of work assigned to Insect races is proportionately increased. Is it not natural to imagine that the functions performed by them in a colder climate, would in a warmer one require increased exertion and capabilities? It does not follow, because we find new types of form in tropical countries, and new genera of superior bulk and power, and more abundant in individuals, that therefore they necessarily replace the old ones, and are to perform the duties peculiar to both regions; both may live and thrive together, and abound in the same countries, and will eventually be found to do so. When the genera of temperate climes appear within the Tropics, I see no reason why they may not have the same functions assigned them there, as in colder latitudes; but when we find new types of form, and a more powerful organization, with the size of the Insects greatly increased (as

is the case in tropical regions), does it not almost naturally follow that they are intended solely for those regions, and for the increase of work they are there destined to perform? To return, however, to the subject of uniformity of entomological character throughout the Peninsula and the East, I think it probable that it is in a great measure to be accounted for by the general uniformity of its temperature, vegetation, and soil; there may, indeed, be other causes, which particularly influence it, but these may be esteemed the most essential. When we look to the range which genera here enjoy, it is very considerable: in part of the Himalayas, at the extreme southern points of India, in the West, and even in its Eastern Isles, there is one pervading character, evincing every where the prevalence of tropical genera. To speak more specifically, in Nepal and the southernmost extremity of the Mysore, and in Ceylon, at Bombay, and at Madras, at Calcutta and Singapore, in Japan and Java, with the rest of the Polynesian Isles, the majority of the same types abound; and what is of more consequence, a great majority of the same species also occur in most of the above-mentioned regions. Having noticed the intermingling of genera belonging to Europe and Asia, we may probably find a slight accordance elsewhere. Now, if we turn our eyes to Africa, we shall there find a considerable similarity in the entomology of this quarter of the globe with that of Asia; and this resemblance between the two countries will be readily seen by the short annexed list of some of the more particular genera, which are common to both of them. Among the Carabidæ occur Anthia, Orthogonius, Trigonodactyla, and Siagona. Among the Lamellicornes, Epirinus and Popillia, the conical Buprestidæ and the extraordinary Paussidæ, which last are chiefly found only in these regions; and to these may be added, as well as many more, the genera Melyris, Megalopus, Sagra, and Adorium; Dorylus, among the Hymenoptera, and Diopsis among the Diptera. Passing from genera to species, we shall find that precisely the same occur in both continents; among the most conspicuous, I shall mention but a few, namely, Copris Midas, Sabæus, and Pithecius, Cetonia cornuta, and Lytta gigas. Even supposing that no identical species occurred, which were common to Asia and Africa, yet we could not help observing the very remarkable similarity in the representatives of each; one example of which is, Ateuchus sanctus, which very closely resembles the celebrated Sacred Beetle of the Egyptians, the object of their worship, by some regarded as an emblem of fertility, but I think more probably that of eternity. Before concluding my remarks on the similarity of Insects found in Asia and Africa, I cannot help expressing a wish that some individual may be induced to develope the character of the entomology of these gi-

gantic regions more thoroughly than has yet been attempted; or there is an ample field for research and speculation. We shall feel much indebted to him, if he will explain how the Copridæ were transported from one country to another, and how they reached the island of Ceylon; how also Cetonia cornuta, which is taken on the banks of the Gambia, became an inhabitant of India. Lytta gigas may have travelled by land, and perhaps the Copridæ following the track and droppings of the camel, may have pursued the same route. Let him describe the sands of the desert and those in the vicinity of the Indus, give us a comparative Fauna of the Ganges and the Nile, record the varieties of temperature, the character of vegetation, and the genera peculiar to the different soils. Let him do this, following the steps of the celebrated Forskal, and he indeed will advance the objects of science, deserve the thanks of the present generation, and command the respect of posterity.*

Descriptions of Insects, *by* J. O. Westwood, Esq., F.L.S.

ORDER DERMAPTERA LEACH.

Family Forficulidæ.

Forficula Macropyga, Westw.

Piceo-nigra, punctata, abdomine æneo submicante, marginibus thoracis, tegminibusque rufescentibus, forcipe (♂) longissimo valde curvato, et gracili; (♀) fere recto tenuissimo.

Long. Corp. (forcipe excluso) ♂ lin. 6 ♀ lin. 5.

Ad genus Forficulam (stricte sic dictum Servilleo) appertinet, statura fere Forficulæ auriculariæ et paullo robustior, caput nigrum punctatum, impressionibus duabus anticis inter oculos. Antennæ ♀ (♂ mutilatæ) 13-articulatæ graciles rufescentes, articulis bassalibus obscurioribus.—*Prothorax* planus antice vix emarginatus, lateribus antice rectis, postice rotundatis, niger punctatus, margine tenui rufescenti; foveolis duabus rotundatis, antice impressus.—*Tegmina* piceo-refescentia, punctata, portio alarum detecta concolor. *Abdomen*

* By pursuing the course recommended by Mr. Hope, a naturalist would be enabled, not only to display the connection between soil, temperature, and vegetation, as well as the animal forms which the latter supports, but also prove the advantages of studying the natural sciences in connection with each other, and be enabled to explain something of the laws which influence the geographical distribution of plants and animals.—J. F. R.

nigro-picum punctatum æneo submicans; segmento penultimo lateraliter et angulariter producto (♂) aut simplici (♀). Forceps (♂) niger valde elongatus, gracilis ad basin, valde externè curvatus, in medio, dentibus duobus parvis internis instructus, apice sursum et exterius producto, acuto (♀) elongatus multo gracilior, rufescens fere rectus et inermis.

ORDER LEPIDOPTERA LINN.

DIURNA. FAMILY PAPILIONIDÆ.

PAPILIO MACHAON, Linn.

This handsome butterfly, like Vanessæ Antiopa, and Atalanta, Cynthia Cardui, and some others, affords an instance of wide geographical range,* rather than of representative structure, since the individual figured cannot be regarded as specifically distinct from the European specimens, which differ amongst themselves in various slight particulars, as the size of the dark bars, and spots, &c. It may, however, be noticed, that the specimen figured has the small oval black spot near the extremity of the anterior wings almost entirely isolated, the large basal black portion of the same wings is very strongly covered with yellow powder, whilst the black lunules of the posterior wings are not nearly so much powdered with blue bloom, as in the ordinary English specimens.

FAM. NYMPHALIDÆ.

PAPHIA PARAKEKTA, Horsfield. Lepidopt. Javanica.

Paph. alis anticis ad apicem acutis, posticis subcaudatis; anticis supra ad basin cæruleis, fascia obliqua lata fulva in medio, apiceque nigro; maculisque duabus parvis albis (una discoidali, altera apicali) ornatis; posticis cæruleis.

The preceding characters, drawn from the upper surface of the wings of this remarkable butterfly, will suffice for its determination until the publication of Dr. Horsfield's description. The under surface of the wings are, however, much more remarkable, bearing a most striking resemblance to a pale dried leaf; the deception being much increased by the form of the wings, when brought in contact by the Insect, whilst sitting upon a flower in the sun-shine, the short caudal appendages

* Messrs. Godart and Latreille, in the Encyclopédie Méthodique (vol. IX., Art. Papillon) state, that Pap. Machaon is found in Syria and Egypt.

giving rise to the idea of the stalk of the leaf, thus completing the delusion.

DIVISION ?———? Fam. Zygænidæ ?

Genus Campylotes, Westw.

Genus anomalum Heleonæ et Anthonoyzæ *Sw.* Gymnanto ceræque *Guér*, affine, alæ oblongæ, subovales, integræ, nervis apicalibus valde curvatis, anticæ cellula discoidali clausa nervos duos postice emittens, quorum exterior trifurcatis, posticæ etiam cellula discoidali clausà, nervo recurrente intermedio bifurcato. Corpus parvum abdomine gracili, pone alas haud protenso. Caput parvum. Ocelli 2. Antennæ graciles biramosæ. Palpi brevissimi supra haud discernendi, maxillæ elongatæ s pirales.

Campylotes histrionicus, Westw. Æneus, alis ad costam rufo—, interne flavo-lineatis, maculisque apicalibus albis.

Long. Corp. lin. 11. Expans. alar. unc. 3. Habitat in Nepalia. Hardwicke ; in Montibus Himalayanis, Royle.

Corpus nigro-æneum, palagris maculisque abdominalibus lateralibus flavis. Alæ anticæ æneæ, costa, fasciisque duabus discoidalibus rufis, fasciüsque tribus internis per totam longitudinem alarum currentibus flavis ; maculis 8 vel 9 (spatium inter nervos apicales occupantibus) albis. Alæ posticæ similiter coloratæ, at maculæ terminales flavo ornantur.

This remarkable Insect appears to be the extreme type of a very numerous Indian group of Lepidoptera, to which belong the species named Capys pectinicornis, Thallo, and Rhodope. It is impossible to decide upon their real affinities, until we obtain a knowledge of the metamorphoses of some of the species.

ORDER ORTHOPTERA. Fam. Mantidæ.

Mantis Roylii. Hope, MSS.

ORDER HYMENOPTERA. Section Pupivora.

Fam. Chalcididæ.

Dirhinus Himalayanus, Westw.

Niger, pedibus 4 anterioribus, tarsisque posticis rufescentibus.

Capite obtuse bicornuto.

Habitat in Himalaya.

Long. corp. lin. 2. Exp. alar. lin. 3.

Caput nigrum punctatum, anticé obtusé bicornutum antennarum arti-

culo primo nigro (articulis reliquis deteritis). Thorax fortiter punctatus; metathorace 4 lineato et ad latera, angulariter producto. Abdomen breve depressum thoracis latitudine. Pedes 4 anteriores rufescentes, 2 postici nigri, tarsis solummodo rufescentibus.

Obs. In hac specie partes oris valde elongatæ, labro oblongo-ovali ciliato, mandibulis inter se similibus, gracilibus, sub apice dente interno unico armatis.

ORDER HETEROPTERA. Section Longilabres.

Fam. Scutelleridæ,

Scutellera Pulchella, Hope, MSS.

Cæruleo-nigra vel-æneo, nitida prothoracis disco anticé, et margine postico æneo vel cupreo tincto, scutello aureo viridique intenti, fascia transversa basali, alteraque centrali obliqua, (in medio interrupta) et maculis tribus rotundatis (postice et in triangulum positis) cæruleo-nigris.

Statura fere Scutelleræ mauræ at paullo minor, scutelloque abdomen omnino obtegenti. Scutelleræ Stockeri affinis at robustior. Antennæ articulis duobus basalibus brevibus equalibus. 3tio. 2do. fere duplo longiori, ultimo omnium longissimo.

Long. corp. lin. 5. lat. lin. 3.

Fam. Pentatomidæ.

Megarhynchus Transversalis, Westw.

Fusco-niger, capite acuté bicornuto, angulisque anticis thoracis acuté antice productis, prothorace et scutello transverse striatis, parte coriacea hemelytrorum nigrâ, tenuissime punctata, membranâ apicali albida, antennæ et pedes nigri.

Long. corp. lin. 7½. lat. lin. 3½.

ORDER HOMOPTERA. Section Saltatoria.

Fam. Acadidæ.

Cicada Sulphurea, Hope, MSS.

Nigra, capite thoraceque sulphureo maculatis, alarum dimidio basali sulphureo, parte anticarum sulphurea, fascia obliqua nigricanti divisa, apicibusque fuscescentibus

Long. corp. unc. 1½. Expans. alar. unc. 3¾.

Affinis Cicadæ maculatæ. Caput nigrum orbitu interno oculorum sulphureo ; thorax niger maculis 8 sulphureis abdomen nigrum segmentorum marginibus pallidis. Alæ anticæ costâ sulphureâ, maculâque ovali maximâ (plus quam dimidium basale alarum occupante) sulphureâ fasciâ obliqua tenui nigrâ interné dentatâ divisâ; apice fusco nervis nigris Alæ posticæ ad basin sulphureæ, ad apicem fuscæ nervis nigris ; pedes nigri.

ORDER DIPTERA. Section Pupipara.

Fam. Hippoboscidæ.

Hippobosca Maculata.

Thorace fusco, flavo variegato, scutello nigricanti, maculis tribus flavis, mediâ majori, femoribus tibiisque posticis ad apicem fuscis.

Hippobosca equina; " ex Indiâ orientali paullo major, thoraceque magis albo variegato, at vix distincta." Fab. Syst. Antl. p. 338.

Hippobosca maculata, Leach, " On the genera and species of Eproboscideous Insects." Wernerian Trans. vol. ii. p. 549.

Long. corp. lin. 4 Expans. alar. lin. $8\frac{3}{4}$.

Caput flavum, oculis fulvis, lineâ longitudinali inter oculos fuscâ. Proboscis nigra. Thorax fuscus, maculâ magnâ ad angulos anticos flavescenti in medio fuscâ ; fascia parva centrali lunulisque duabus in medio conjunctis posticis flavescentibus, scutello nigricante maculis tribus flavis media majori. Abdomen fuscum, punctatum, marginibus rufescentibus. Pedes fulvescentes tarsis omnibus femoribus tibiisque posticis ad apicem fuscis.

Fam. Nycteribidæ.

Nycteribia Roylii.

Obscure nigra pedibus fuscescentibus elongatis, vix compressis, coxis anticis brevibus, abdomine ovalo, conico, depresso, 5-articulato, apice subtruncato, stylis duobus incurvis subtus armato, capite compresso.

Long. corp. lin. $1\frac{1}{3}$.

Habitat in Indiâ Orentali.

Nyct. Roylii. Westw. in Trans. Zool. Soc. 1. p. 290-5.

ORDER COLEOPTERA.

Cetonia Roylii, Hope.

Long. lin. 12. lat. lin. 6.

Nigro-viridis thorace flavo marginato elytrisque quatuor maculis flavis notatis. Clypeus quadratus. Antennæ nigræ. Caput quadratum puncta-

tum. Thorax cupreis marginibus externis elevatis, lineaque flava utrinque externa, disco fortissime punctato. Scutellum magnum postice decitum. Elytra nigro-virescentia maculis quatuor flavis notata, binæ fere rotundatæ ad basin positæ, binæ aliæ reniformes ante apicem locatæ. Corpus infra nigro-æneum segmentis abdominis utrinque aurantiis capillis obsitis pedibusque concoloribus.

In Mus. Dom. Royle ; in montibus Himalayæ captus ceria.

Geotrupes Orientalis.

Long. lin. 10. lat. lin. 6½.

Violaceus thorace sparsim punctulato, elytris striatopunctatis, pedibus supra nigris, infra violaceis nitidis. Antennæ piceæ capitulo fuscanti, thorax violaceus longitudinali serie punctorum in medio posita, variis aliis sparsim dispositis. Elytra striato punctata striis quasi vermibus erosis. Corpus infra violaceum nitidum, femoribus posticis uni-spinosis, tibiis pilosis, tarsis chelisque piceis.

This singular species approaches very closely to some of our British species, and is probably from a high elevation of the Himalayan mountains.

In Mus. Dom. Royle.

Onthophagus Phanœoides.

Long lin. 4½. lat. lin. 2¼.

Niger obscurus, clypeo cornu reflexo abrupte truncato, thorace phanæoformi, postice lateribus in spinam obtusam productis, femoribus luteis. Antennæ piceæ capitulo fuscanti : clypeus hexagonus cornu reverso abrupte truncato, thorax fere quadratus ; punctatissimus, punctulis erosis tuberculo antice, fossulaque postice in medio marginis impressa, angulis posticis in spinas productis. Scutellum parvum nitidum. Elytra striata. Corpus suptus atrum nitidum punctatum. Pedes femoribus luteis, tibiis tarsisque nigropiceis.

This singular Insect will, at some future period, form the type of a new genus : in form it unites the South American Phanæus, and the widely-disseminated genus Onthophagus.

Lucanus Lunifer.

Long. lin. 37. lat. lin. 10.

Æneo-piceus, areolo tomento aspersus, mandibulis exsertis unidentatis, denticulisque minoribus instructis, apice bifurcatis. Clypeo deflexo lunifero, femoribus castaneis.

Hab. in Montibus Himalayæ ; in Mus. Dom. Royle.

This Insect appears to unite in itself the characters of the Asiatic and

European species, the latter rather predominating over the former: it is one of the finest forms of the Himalayan Fauna.

Lamia Wallichii.

Long. lin. 16. lat. lin. 5.

Viridisericeus, Antennis penicillatis, elytris tribus fasciis nigris, binisque penicillis dosalibus ornatis. Antennæ corpore longiores et nigro-virides, primo articulo subpenicillato, tribus sequentibus atris, penicillis magnis pilorum barbatis, et reliquis pubescentibus, ultimo tamen pubescentia densiori tecto. Thorax viridis, spinosus. Elytra ornata tribus fasciis vix suturam attingentibus, una in medio elytrorum, secunda inter mediam et apicem, tertiaque binis penicillis dorsalibus interrupta. Corpus subtus nigro-virens, sanguinea pubescentia aspersum. Segmenta quatuor abdominis sanguineo colore fucata, ultimum omne autem viride et nitidum. Pedes viridi-pubescentes, femoribus maculâ rufâ notatis tarsisque infra flavis.

It is impossible to describe accurately the beauty of this Insect; the sericeous covering, in different lights, imitating the various tints of opal, while the dark fasciæ flash with the iridescence of Labrador felspar.

PORUS, Hope.

{ Stenidæ, ML.
{ Longipalpi, Lat.

Corpus oblongum fere parallelum subdepressum. Caput mediocre oculis magnis lateralibus. Antennæ crassæ articulis transversis. Mandibulæ acutæ dente interiori armatæ. Labrum transversum integrum ciliatum. Maxillæ elongatæ bilobatæ. Palpi maxillares longitudine mediocres articulo 3tio. longo clavato, ultimo minimo. Labium elongatum apice lanceolato, paraglossis lateralibus. Palpi labiales breves, articulo ultimo parvo conico. Thorax fere circularis. Abdomen elongatum marginatum. Pedes simplices. Tibiæ calcaribus binis armatæ Tarsis articulis simplicibus.

Porus ochraceus. Long. lin. 4. lat. lin. $\frac{3}{4}$.

Elytris punctatis antennis fuscis, mandibulisque ad apicem nigris.

Hab. in Montibus Himalayæ; in Mus. Dom. Royle.

This genus somewhat approaches our European Evæsthetus.

APHODIUS.

Aphodius irregularis, Hope.

Long. lin. 4. lat. lin. 2.

Flavus thorace nigro, elytris subaurantiis, fascia media maculis quatuor

nigris, pedibusque piceis. Antennæ piceo capitulo fusco. Caput angulis anticis oblique truncatis. Thorax niger nitidus punctatus, angulis anterioribus flavis. Elytra flava, seu subaurantia, fasciâ mediâ irregulari nigrâ, binis maculis humeralibus, binisque aliis fere ad apicem locatis concoloribus.

Hab. in Montibus Himalayæ; in Mus. Dom. Royle.

ANISOTELUS, Hope:

Telephoridæ.

Antennæ articulo Imo. crasso, reliquis multo crassiori, 9-10 obconices magnitudine paululum crescentibus ultimo majori ovato apice acuto. Mandibulæ valde acutæ. Maxillæ membranaceæ lobo unico intus tomentoso. Palpi articulo 1mo. minimo, 2do. et quarto æqualibus, ultimo subsecuriforme. Mentum transversum. Labrum membranaceum fere rotundatum. Palpi labiales breves, articulo ultimo majori securiformi. Caput transversum oculis prominulis. Thorax transversus lateribus rotundatis, angulis posticis acutis elevatis. Elytra sicut in Telephoris, in medio nonnihil dilatata. Tarsi 5-articulati, articulo penultimo bilobato.

Anisotelus Bimaculatus, Hope.

Long. lin. 4½., lat. lin. 2.

Lividus, elytris 2-maculatis. Antennæ articulo primo testaceo, reliquis fuscis. Thorax rufo-testaceus nitidus, elytris pallidioribus macula ovali nigra in singulo fere ad apicem posita. Corpus infra testaceum.

Hab. in Montibus Himalayæ; in Mus. Dom. Royle.

Elater Cyanopterus, Hope.

Long. lin. 4½., lat. lin. 1¼.

Cyaneus, antennis fuscis, marginibus thoracis pedibusque rubris. Caput nigrum antennis fuscis. Thorax in medio nigro-cyaneus, marginibus lateralibus rubris. Elytra striato-punctata subpubescentia. Pedes rubris.

Hab. in Montibus Himalayæ; in Mus. Dom. Royle.

Ripiphorus Apicalis.

Long. lin. 3., lat. lin. 1.

Rufus, thorace pedibusque nigris, elytris flavo-rufis quatuor maculis notatis. Caput atrum ramo antennarum piceo, foliisque nigris. Thorax concolor. Elytra flavo-rufa, basi nigrofasciata, maculis binis fere mediis, apicibusque corporeque infra nigris.

Hab. in Montibus Himalayæ; in Mus. Dom. Royle.—*Royle's Illustrations of the Botany, &c. of the Himalayan Mountains, Supplementary Part.*

(In connexion with the foregoing the following *Desiderata in the Entomology of India*, by the Rev. F. W. Hope, are republished from the *Calcutta Journal of Natural History.* No. 1.)

1.—Parasites of Birds, Lice, (*Nirmi*). Parasites of *Reptilia* (*Acari*) the name of the genus and species should be given on which they are found. Parasites of Quadrupeds, Ticks, &c.

2.—Endeavour to ascertain if the larger Beetles of India live more than one year; it is important also to ascertain the sexes of the *Atlas Beetles*, and the uses to which their horns are applied.

3.—Ascertain the names of the trees which yield *Resin Anime*; and if any other resins in India contain insects.

4.—Among *Coleoptera*, attend chiefly to the *Lamellicorn Beetles*, *Cetonia*, *Copris*, *Scarabæus*, and *Baprestidæ*.

5.—Ascertain by dissection of gigantic *Coleoptera* if the organs of hearing are in the basis of the antennæ as in *Crustacea*; collect the larvæ of all large *Beetles*, and try if they have the power of hearing.

6.—Send me an account of the habits of *Paussus*, and all the species you can obtain.

7.—Any species of insects infested with worms, should be noticed. The worms should have drawings made of them before put into spirits.

8.—All hermaphrodite insects to be noticed, as well as irregular copulation of different genera.

9.—All *Carrion Beetles* to be attended to. They are supposed to be *scarce* in India. The prejudice of caste and of religion will not allow many of the natives to touch a dead body of any animal.

10.—All species of silk-bearing insects used in commerce, with their local names and larva, eggs, &c. It is probable we may breed the Atlas Moths in England. Send Larvæ of any, placed in mould, when an opportunity occurs. Colonel Withill introduced alive into England *Bombyx Selene*. Any reports of the annual produce of silk useful.

11.—*Cochineal*, new species; intelligence wanted about its range. How many species in commerce in India. *Lac insect* also.

12.—*Bees*. All species of Bees to be collected. Any accounts of the produce of honey. The *native names* of Bees much wanted; any thing remarkable in the combs to be figured. All *parasite beetles* found in Bees' nests much wanted. Imports and exports of honey and wax. What are the Bees which produce the wax of the Chinese candles? there are several sorts.

13.—*Ants*. Collect all species of Ants—males, females, and neuters. Ascertain if they *lay up* stores of grain, seeds, &c.; be careful in marking the species. What Ants will drive out the White-Ants? Are the

different kinds employed by the natives, to drive out those which annoy them? Experiment on the formic acid. If the White-Ants' nests are ever used as ovens.

14.—*White-Ants.* Collect all species; attend to their parasites, particularly the *Beetles*, which attack them, and are found in their nests.

15.—What insects are eaten as food? Their Indian names. What *Locusts* are eaten, &c.?

16.—Mark those insects which cause any particular destruction of crops, and if the destruction is periodical.

17.—Mark all *luminous* insects. Ascertain if the *Lantern Fly* is *luminous*, it is disputed.

18.—What species of *Mygale* are in India? Their habits. What spiders yield silks, such as are found in commerce?

19.—What species of vesicatory insects are used in India? If any besides *Lytta* and *Mylabris.* If any insects are used medicinally. Their names.

20. Record any instance of death occasioned by insects, by Bees, Wasps, Hornets, or by Flyblowing, &c. Any ailments produced by insects swallowed in the larva state, &c.

21.—Is *Resine Anime* a preservative against the attacks of insects? Said to be used in corking bottles. Is cloth *coloured by Indigo* ever attacked by the White-Ants and other insects?

22.—Any native remedies against Cockroaches? Collect all species of, and particularly all sorts of *Earwigs.*

23.—Native remedies used after the stings of insects, and the attacks of Gnats, Scorpions, Centipedes, &c.

24.—Note all insects infesting houses. Does any true *Ptinus* occur in the East Indies?

25.—Species of *Æstrus* attacking quadrupeds; collect them. Do any attack man in the East?

26.—Collect all Aquatic Beetles. Do the *Gyrene* of India emit a peculiar smell? Do the *Carabe* emit an ammoniacal odour?

27.— Collect all Land-Crabs and inland *Crustacea.*

28.—Observe particularly the insects which destroy corn, rice, and all stores. What checks are in use?

29.—Note any extraordinary migration of Caterpillars, and indeed of all other insects.

30.—The *Mole Cricket* of the East Indies. What are its habits?

31.—Note the appearance of the clouds of Locusts.

32.—What are the preservatives used by the Indians in guarding their feathers and shawls? Colocynth supposed to be used.

33.—What genera and species of insects are used by the natives, in necklaces and ornaments, &c.?

34.—The habits of the large *Stag Beetles*. Do they destroy leaves?

35.—Note all odorous smelling insects.

36.—Are Beehives in use in India? Send specimens of domestic Bees, if they are domesticated.

37.—Is the *Sherifah*, or Custard-Apple seed, injurious to vermin? Flies are reported never to settle on the tree or its fruits. Ants will attack both.

38.—From what quarters chiefly do clouds of Locusts come?

IX.—*Memoir on the Mammalogy of the Himalayas.—By* Wm. Ogilby, Esq., m.a., *Fellow of the Royal Astronomical, Geological, Linnæan, and Statistical Societies; Secretary of the Zoological Society.*

In the early part of the year 1833, Professor Royle put into my hands an extensive Collection of Zoological Specimens, made during his excursions through the Western parts of the Himalayan Mountains, of which the rich Botanical results are now in course of publication, with a request that I would furnish him with a Catalogue *Raisonnée* of the different species of which it contained the spoils, to be added as an Appendix to his work. Whilst occupied in this easy and unostentatious task, various observations presented themselves, which induced me to propose to my friend a slight alteration of his original plan, so as to embrace a general outline of the Mammalogy of the Mountain Regions of Northern India, for the purpose of exhibiting, at one view, the intimate relations which I soon perceived to subsist between the animal productions of this elevated and extensive mountain chain and those of Northern Europe, Asia, and America. It soon became obvious, in fact, that the Zoology, like the Botany of the Hills, differed essentially from that of the sultry plains of India, which skirt their southern base; that, though occasionally mixed with tropical forms, it was, upon the whole, of a character closely resembling that of the more temperate and northern latitudes; and that the insulated position of these remarkable mountains, exhibiting, as they do, the rare and interesting phenomenon of a temperate and even a boreal climate on the very confines of the tropic, where the summer heat is necessarily greater than even under the equator itself, gave an importance to the inquiry, as connected with the geographical distribution of Animal Life, which promised the most important results. The nature of the

problem, indeed, and the very different conditions of Animal Life, as compared with that of Vegetables, forbade me to anticipate the discovery of laws of distribution in the Animal Kingdom, so definite and circumscribed as those which Baron Humboldt has established with regard to Plants; the principle of animality, if I may be allowed the expression, possesses an innate power of adaptation which renders Animals in some measure independent of climate, particularly as compared with Vegetables, and which increases in proportion as we ascend in the scale of life; but I felt that if any such laws of geographical distribution prevailed in Zoology, they might naturally be expected to be exhibited most clearly and unequivocally on a theatre like this, and therefore that the opportunity should not be neglected of investigating the circumstances of a problem which appeared to promise so much scientific interest.

From the observation just made, *viz.* that the power which all animals possess, in a greater or less degree, of adapting themselves to different varieties of climate, and of withstanding, uninjured, the effects of temperatures foreign to their natural habits, increases in proportion as we ascend from the lower to the higher tribes, it will be seen that the Mammalia—the class which I had undertaken to review—form one of the most unfavourable groups for the discussion of this important question. Indeed, were it not from their limited powers of locomotion, they would be the very worst of all, because their high position in the scale of life, and the superior intelligence and resources with which it endows them, necessarily protect them against changes and casualties, which would prove fatal to more simply organized beings; but, deprived of the powers of flight, ordinary Mammals have not the means of traversing the wide deserts and oceans, which separate the habitable portions of the earth: the nature of their locomotive powers consequently confines them to particular regions; and, in spite of the more favourable circumstances of their physical organization, their more varied resources and superior intelligence, they afford better materials for studying the problem of geographical distribution, than the kindred class of Birds, whose faculty of rapid flight enables them to set oceans and deserts equally at defiance, in passing to the most distant quarters of the globe, and, as it were, to choose their own temperature and climate in the boundless fields of air. Hence it is that the circumstances of the important problem of geographical distribution are less favourably presented in Ornithology than in Mammalogy; but, with this exception, the observation above made holds good throughout all other classes of animals, and the simplest tribes will always be found to present the most certain results. Insulated families also occasionally occur, which possess peculiar advantages for the

prosecution of this inquiry ; as, for instance, in the case of fresh-water Fishes, than which I am acquainted with no other group of animals so well calculated to illustrate the laws of geographical distribution, or so likely to repay a careful study under this point of view ; and I am only surprised that no competent Ichthyologist has hitherto occupied himself with so promising an inquiry.

The only other principle which can well be regarded as influencing the geographical distribution of Animals, *viz.* the dispersion of Plants, upon which all Animals live, either mediately or immediately, is obviously subordinate to that of climate, with which it has been shown to be most intimately connected. On a limited scale the distribution of particular species may be seriously affected by the influence which civilization and cultivation produce upon the face of particular countries ; wild animals necessarily disappear with the woods and forests which afforded them food and shelter ; the Wolf, the Bear, and the Beaver, have thus disappeared from our own country ; the Capercalzie, exterminated about a century ago, is once more spreading rapidly over the pine forests of Scotland ; but these are partial cases, which do not bear upon the general problem of geographical distribution ; and it is obvious, that upon the great theatre of nature, climate and temperature are the only laws which regulate it, limited, indeed, by the physical structure of the animals, as has been already observed, and by their powers of transporting themselves to distant regions. Hence it is that terrestrial and fresh-water tribes are more favourable for this study than marine or pelagic ; though even among the latter, the comparative simplicity of their structure, and their consequent susceptibility of changes in temperature, render the habits of different genera and species more definite and confined than might otherwise be expected. Of the former, again, land and fresh-water Mollusks being among the most simply organized, are consequently most limited in point of range ; the species of Insects are almost equally confined, unless in the case of certain tribes, which are susceptible of being transported to distant countries in wood and other extraneous substances ; next follow Reptiles and fresh-water Fishes ; and, last of all, Birds and Mammals ; the former, as already observed, having an almost unlimited range of habitat, from the facilities which they derive from their powers of flight, of passing to the most distant quarters of the globe. The common Sparrow, the Snipe, and the Woodcock, for instance, are found in the Himalayas and in Japan, as well as in the North of Europe ; nature has endowed these birds with means of traversing the arid climes and extensive deserts which intervene between these localities, which she has denied to Quadrupeds ; and hence we must not expect to find the Badger and the Fox so widely distributed

as the Owl and the wild Goose. But if the same species of Mammals are confined to particular regions, the great question still remains, whether similar regions, wherever situated, or however separated from one another by intervening seas and deserts, produce kindred or analogous species of Mammals? and it is the general solution of this question in the affirmative, as far at least as the great continents of the globe are concerned, which renders the Mammalogy of the Himalayas so interesting in this point of view. We have here an insulated territory on the confines of the tropic, with a climate varying from the most intense heats of the Equator to the greatest rigours of the Pole; and we shall find, in discussing its animal inhabitants, that it presents, as it were, an epitome of the Mammalogy of the world; an intermixture, or rather a succession of species and genera similar to that which we meet in travelling from India to Kamtschatka, or from Brazil to Labrador.

Having thus fully explained the objects, it now only remains for me to acknowledge the sources from whence I have derived the materials of the following Memoir. The principal of these has been, of course, the Collection of Professor Royle himself, and the few notes, rendered particularly valuable, however, by containing the native names and localities, made by that gentleman during his tours. Besides which, the extensive Collections of the British Museum, of the Museums of the Zoological Society, the East-India Company, and various private collections of less note, which are occasionally made by Officers, and sent to their friends in this country, many of which I have had the good fortune to examine, have furnished me with valuable materials; whilst the different Notices and Memoirs on Indian Zoology, dispersed through the pages of the Asiatic Researches, the Journal of the Asiatic Society of Bengal, the Zoological Proceedings, and other similar publications, have been consulted with the greatest advantage. By carefully quoting my authorities, I have invariably taken care to distinguish what I have seen or know myself, from what is merely given on the faith of others. Yet with all these resources at my command, I have found my materials much too limited to give any thing beyond a mere outline of the Mammalogy of the Himalayas; but if this Memoir should prove to be the means of inducing future travellers, or residents, in those interesting regions, to fill up the sketch thus imperfectly traced, or assist them to distinguish what is already well known, from what still continue to be desiderata, in these inquiries, it will not have been without its use. The present time, indeed, is peculiarly favourable for such pursuits. India now contains many able and zealous naturalists; and what is not less fortunate, has a Nobleman for its Supreme Governor who both understands and can ap-

preciate the value of their pursuits. Drs. Cantor, M'Clelland, and Falconer, are skilful and practised observers; and Mr. Hodgson appears only to want access to European libraries and museums, an advantage unfortunately beyond the reach of the Indian Naturalist, to illustrate the Mammalogy of Nepal in the most ample and satisfactory manner.

Before leaving this part of the subject, I shall take the opportunity of offering a few remarks, which may be useful to that numerous class of intelligent and educated gentlemen, who are dispersed over every part of India; and who, from their taste for field sports and the facilities afforded by their situations, have the means of making the most valuable observations in various departments of Natural History; but which are too often neglected, not from any deficiency of zeal or inclination on the part of the observers, but from a want of practical experience in observing, from the difficulty of naming and describing the animals which fall under their notice, and from not knowing exactly what points to attend to. An accurate knowledge of specific differences, however, is by no means indispensable for this purpose; generally speaking, it is sufficient to indicate the affinity of the animal to the most approximate European species, and to ascertain its native name, in order to enable the more practised Zoologist to recognize it with sufficient accuracy, especially if the forms of the feet, teeth, ears, &c. be carefully noted: but the main points to be attended to, and those, unfortunately, which the generality of observers most neglect, are the habits and economy of the animals which fall under their notice; their manners, whether aquatic, arborial or terrestrial; whether they inhabit burrows, or reside among thick jungle, or on the naked open plain; whether they live in society or solitary; the number of young which they produce at a birth; their period of gestation; the duration of life; their instincts, and the stratagems which they employ to capture their prey or to escape from their enemies; the nature of their food; whether they hibernate or migrate from place to place, according to the season; whether they are turned to any account by the natives, or are capable of yielding any products applicable to the purposes of commerce or domestic economy. These, and other similar inquiries, of the utmost importance to the philosophical Zoologist, are within the ordinary range of daily observation to most gentlemen in India, with respect to many rare and interesting animals; whilst they are, generally speaking, attended with so little trouble, and at the same time productive of so much mental recreation and instruction, that it is only surprising how much they have been heretofore neglected. One principal cause of the apathy which our countrymen in India have shown, if not in making, at least in recording,

their observations on various branches of Natural History, may, indeed, have arisen from the want of some common central institution, where they could be properly arranged and published; but the establishment of the Zoological Society of London, and the unrivalled resources which it possesses, offer facilities for this purpose, which it is hoped will hereafter be made extensively available by Englishmen in all parts of the world. It is scarcely necessary to add, that any interesting details relative to the habits and manners of foreign animals, observed in their native climates, will be gladly received from any quarter, and published in the Proceedings of the Society; especially if accompanied by the skins of the animals (the skulls, legs, and tail, being carefully preserved), for the purpose of identification. The Journal of the Asiatic Society contains numerous articles on Natural History, but its contributions in this department are fewer than could be wished: whilst the Bengal Sporting Magazine, hitherto in a great measure confined to mere journals of shooting excursions, might likewise be made a ready and appropriate medium for the publication of such observations; and the contributions of its various correspondents prove them abundantly qualified for this higher and more important object.

These introductory observations being premised, I shall now proceed to enumerate such Mammals as I know to inhabit the great Himalayan Chain; and without following any formal arrangement, shall throw them into such natural groups or families, as appear best suited to illustrate their geographical distribution with respect to climate and temperature, the principal object of the present Memoir.

QUADRUMANA.

Throughout Bengal and the nothern provinces of British India, there appear to be only two species of *Simiæ*, the Hoonuman (*Semnopithecus Entellus*), and the Bhunder (*Papio Rhesus*); both of which ascend the hills to a very considerable elevation during the summer heats, and return again to the plains at the commencement of the cold season. This migration is a very interesting fact in the history of these *Simiæ*; it is the only instance of a similar phenomenon, which has been recorded of this family of Mammals, and may become of great value in its application to geological reasoning on the climate and temperature of Europe during the tertiary epochs, in the deposits of which periods the bones of Apes and Monkeys have lately been found, associated with the remains of Pachydermata, and other inhabitants of more tropical latitudes. The Hoonuman, called *Lungoor* by the Hill tribes, is not unfrequently found at

an elevation of from 9,000 to 11,000 feet, as among the Pine forests in the neighbourhood of Choor, and sometimes even at the verge of the snow-line. Nay, it even appears to have succeeded in crossing the mountains; Turner* mentions having seen a large troop of these monkeys in Bootan, where they are held in the same veneration as in Hindustan; and that it has found its way, and is capable of subsisting in a state of nature, at a considerable elevation, and a comparatively low temperature, is sufficiently evinced by these facts, as well as by the testimony of Fraser,† Traill‡ and other intelligent travellers. Dr. Royle found it common enough in the neighbourhood of Hurdwar in April, and on Tuen and Manma at 9,000 feet of elevation in the latter end of May and in June.

The Bhunder, Bender, or Bandar, the Common Monkey of Bengal and Upper India (*Papio Rhesus*), though said by Mr. Hodgson to exist in the central regions of Nepal, only in the vicinity of the temples, and in a semi-domestic state, whence he conjectures it to have been introduced from religious motives, is also reported to abound in Kumaon; and it is highly probable, that the nearly allied species (*Papio Assamensis*) lately discovered by Mr. M'Clelland in Assam, ascends the more eastern hills, as its congener does the central and western ranges. Of this, however, we have no positive knowledge, though the close affinity of the animals gives a strong degree of probability to the fact; but the various species of Monkeys which Mr. Fraser thinks may be found along the upper courses of the Jumna and Ganges, rest on more questionable authority; and it is not unlikely that this intelligent traveller, as indeed he has himself conjectured, was deceived by distance, variety of size, and other circumstances, which give a very different appearance to individuals of the same species. Mr. Hodgson§ gives the Bonnet Monkey (*Cercopithecus radiatus*) as a native of Nepal; but this species is confined, as far as at present known, to the Peninsula and western coast of India, and seems to have been confounded by Mr. H. with the *Papio Rhesus*, or Bhunder of Hindustan. The same gentleman, in a letter to the Zoological Society, written some years ago, mentions that his shooters were once alarmed in the Kachar, or Alpine regions of Nepal, by the appearance of a wild man, which walked erect, was covered with long dark hair, and had no tail. The improbability of finding a real Ape in such a situation led him to question the truth of the report; but it is well known that the woods of the lower ranges to the east of Nepal contain at least one species of Gibbon, *Hylobates Scyritus*, called *Hooloo* or *Hooloc* by the Assamese; and

* Journey to Thibet, p. 147. † Journey in the Himalayas. p 351.
‡ Asiat. Res. XVI. 153.
§ Proc. Zool. Soc. II. 96.

it is not improbable that individuals may occasionally wander to the higher and more remote forests of the Central Hills.

CHEIROPTERA.

When it is recollected that of the sixteen species of Bats, now known to inhabit the British islands, no fewer than ten have been discovered within the last few years, it will not appear surprising that we should be so imperfectly acquainted with this department of Himalayan Mammalogy. Mr. Hodgson, indeed, is the only author who has furnished us with any details on the subject: his " Synopsis of the Vespertilionidæ of Nepal," published in the Journal of the Asiatic Society of Bengal, vol. iv. p. 699, contains an enumeration of seven species of *Cheiroptera*: but, as he himself very candidly observes, his specific identifications must be received with considerable caution, from his want of access to extensive libraries and museums, for the purpose of comparison. Of the two species of *Pteropus*, for instance, which he has there briefly described under the names of *P. leucocephalus* and *P. pyrivorus*, the former does not appear to differ from the *P. medius* or *Edwardsii* of the Plains; and the probability of its identity with that species is increased by the fact, which Mr. Hodgson mentions, of its only visiting the temperate regions of Nepal during the autumn, returning of course to the more sultry plains of India on the approach of the cold season. The *Pteropus rubicollis* of Mr. M'Clelland's "list of objects of Natural History collected in Assam," is likewise identical with the *P. Edwardsii.* The only other species of tailless *Pteropus* known to inhabit the continent of India, *Pteropus Dussumieri*, is very different in its characters from *Pteropus medius;* and as Dr. Royle brought undoubted specimens of this latter species from the lower hills a little farther west, it is but reasonable to suppose that it is equally common in Nepal, and consequently identical with Mr. Hodgson's animal. The *Pteropus pyrivorus*, to judge from the short description given by Mr. Hodgson, appears to be less questionably a new species: it belongs to the second section of the genus, having a short tail, partly free and partly enveloped in the membrane, and derives its specific name from the depredations which it commits among the ripe pears in the central regions of Nepal. The migratory habits ascribed to these *Pteropi* are common to the *Pteropus poliocephalus* of New South Wales, and many other species of the same genus; for these large frugivorous *Cheiroptera* are essentially tropical in their habitats, and only visit more temperate climates during the summer and autumn heats, when the ripe fruits tempt them to wander from their native regions. They are conse-

quently but occasional visitors to the higher elevations and latitudes of the globe; and the *Pteropus dasymallus* and *Pteropus pselaphon*, which have been hitherto observed only in Japan, comparatively a high latitude for these animals, do not probably form an exception to the general law.

Of the *Insectivorous Cheiroptera*, a family far more abundantly and extensively dispersed over the surface of the globe, Mr. Hodgson indicates only five species as natives of Nepal. Three of these are described as *Vespertiliones*, by the specific names of *formosa*, *fuliginosa*, and *labiata*, and two as *Rhinolophi*, by the names of *armiger* and *tragatus* respectively; but without a more careful examination and comparison with other species than Mr. Hodgson had it in his power to make, it is impossible to say how far these Bats may be distinct from, or identical with, species already described. One thing at least is certain, that the temperate and more elevated regions of the Himalayas must contain many species of *Insectivorous Cheiroptera*, still unknown or undistinguished, besides those enumerated by Mr. Hodgson; it has been already observed, that this section of the family is very widely and generally distributed in temperate climates; and the rich harvest which has attended the researches of British naturalists, within the last few years, in their own country, ought to stimulate our Indian brethren to a pursuit which cannot fail to be rewarded by still more extensive discoveries. It would be extremely interesting, for example, to procure a complete series of Himalayan Bats, with the seasons, temperatures, and elevations at which they were captured carefully noted down, so as to compare them with analogous species of higher latitudes, and thus ascertain what law of succession the different forms may follow, or within what limits they may be confined in respect to temperature, in their geographical distribution over the surface of the earth. Speaking of these *Insectivorous Bats*, Mr. Hodgson observes, that " they are neither migratory nor subject to hibernation;" two properties which in more northern climates would be considered incompatible with one another, and which even in the central regions of the Himalayas require a very careful revision before they can be admitted as established facts. I am not aware that these animals ever migrate in any climate; hibernation is the resource which nature has provided to preserve them during the season when their natural food disappears; and it is the general opinion, that even within the tropics, the Insect-feeding Bats go to sleep at certain seasons, as they do throughout the winter in more northern latitudes: should the fact be otherwise, it would prove a highly interesting addition to our knowledge of their habits; but it is possible that Mr. Hodgson may have been led into error, by the casual appearance of a few individuals during an occasional fine

evening, as sometimes occurs in Britain even in the depth of winter. The subject is well worth the attention of Indian Zoologists.

INSECTIVORA.

Ascending gradually from the *frugivorous Cheiroptera* of the Plains of India, which visit the hills only during the summer heats, through the insectivorous genera of the same family, which remain throughout the whole year, we next come to the *Insectivora*, properly so called ; a family which belongs almost exclusively to the temperate regions of the earth ; and of which it is therefore extremely interesting to find the common forms of Europe and Northern Asia occurring in the analogous climates of the Himalayas. No fewer than three distinct species of Hedgehogs, for instance, have been described from the Western Hills :

Erinaceus spatangus, a small dark-coloured species, not more than twice the size of a large mouse ;

Erinaceus Grayii, of a grizzled black and yellow, from the spines being annulated with these two colours, rather smaller than the common European species ; and

Erinaceus collaris, by some supposed to be identical with *E. Grayii*, but easily distinguished by a white collar half surrounding the neck. All these species, however, require a careful revision ; they are founded on single specimens, those of the two former deposited in the Zoological Society's Collection, that of the last in the British Museum, and of which a figure is published in the Indian Zoology of Messrs. Hardwicke and Gray. It is possible that more extensive and accurate observation may prove the whole three to be identical: at all events, it is certain that one, either of these, or a different species (*Erinaceus indicus* of Royle's Illustrations, &c. p. 6), inhabits the neighbourhood of Delhi, where it would be interesting to observe the phenomena attending its hibernation, such as the temperature of its body, the nature of its respiration, &c. during the period of repose. Mr. Hodgson, in the letter to the Zoological Society, already referred to, denies that there are any Hedgehogs in Nepal, but mentions a small dull slaty-blue variety of the common Indian Shrew or Musk Rat (*Sorex indicus*), as common in the lower and central regions, to which he speaks of it as being confined. Other species no doubt exist in the more temperate parts of the mountains, though their small size and shy habits screen them from observation. The same gentleman mentions the Mole (*Talpa*), as abounding in the Kâchar, or northern region of Nepal, and Traill* says it is common

* Asiatic Researches, vol. xvi. 153.

in Kemaon; but no one appears to have described, or even examined it, and we are ignorant of every thing relating to it, except the name. It will probably prove to be a distinct species from its European congener, if it exist at all; but the question is involved in great doubt, and is well worthy of a careful examination.

CARNIVORA PLANTIGRADA.

Of this family, the majority of which likewise belong to the temperate regions of the earth, various forms and species occur among the Himalayas. First, of the genus *Ursus*, we have the *Bhaloo*, or Common Bear of India (*Ursus labiatus*), and, according to Mr. Hodgson,* the Malay Bear (*Ursus Malayanus*), inhabiting the Turai, or sultry regions, at the base of the mountains, to which localities he appears to intimate that they are confined. But the habitat here assigned to the Malay Bear is extremely doubtful. It rests solely on the authority of Mr. Hodgson, who, from the want of proper means of comparison, is often mistaken in the identification of species; moreover, we have never received this animal from any part of Continental India, but only from the great islands of the Indian Archipelago; and it is therefore not improbable that it may have been in this instance confounded with the *Ursus Thibetanus*, which, from the general similarity of the two species, may have readily happened. Mr. Hodgson, indeed, expressly mentions this latter species as an inhabitant of the Central and Northern regions of Nepal; and Dr. Royle informs me, that it is confined among the more western hills, to the Doon and warm valleys, where it is called Reech by the natives. Lieut. T. Smith, of the 15th regiment N. I., however, an officer well acquainted with the Mammals of the Himalayas, and a keen sportsman, assures me that the Common Sloth Bear (*Ursus labiatus*) does not ascend above the lower spurs of the great Mountain Chain of Northern India; that it is there replaced by the *Reech* or *Reek*, which occupies the whole of the more elevated hills, as far up as the snow line, where it is succeeded in its turn by the *Barji* or Yellow Bear (*Ursus isabellinus*), a species hitherto very imperfectly described, though mentioned by every tourist as extremely abundant in the higher regions of the Himalayas. Capt. Skinner† met with it in the neighbourhood of Bhairo Ghati; Traill‡ found it in Kemaon, though he says it is peculiar to Bhot; and it is probably the Brown Bear mentioned by Mr. Fraser:§ so that upon the whole it appears, that whilst the

* Proc. Zool. Soc., ii. 96.
† Excursions, &c. ii. 72.
‡ Asiat. Res., xvii. 16.
§ Journey, &c. p. 351.

Common Sloth Bear (*Ursus labiatus*) is on all hands admitted to be confined to the sultry plains of India, the Reech (*Ursus thibetanus*) succeeds it, as the legitimate representative of the European Bear (*Ursus Arctos*), and of its American analogue (*Ursus americanus*), in the middle or temperate regions of the hills, to be itself replaced among the frozen peaks of the higher mountains, by the *Barji*, or Yellow Bear of the Himalayas (*Ursus isabellinus*), a species in all respects analogous, in its colour and habitat, as well as in its decidedly carnivorous appetite, to its congener, the Polar or Sea Bear of the North (*Ursus maritimus*).

Various animals, either belonging or closely allied to the Gluttons and Badgers (*Gulo* and *Meles*), pre-eminently northern forms, likewise inhabit the elevated ranges of the Himalayas. Among the lower terraces we have the Ratel (*Rattelus mellivorous*), called *Peejoo* by the Hindoos, which is common over all the plains of Northern India, and differs from the same animal, as found at the Cape of Good Hope, only in being of a lighter colour on the back. This wide distribution of the *Carnivora*, and the common occurrence of the same species in India, and the most remote parts of Africa, will be more particularly mentioned in the following article: Mr. Hodgson,* under the erroneous impression that the Peejoo, which the Nepalese call *Bharsiah*, was an unknown animal, and evidently misled by some imperfect or faulty account of its dentition, has recently described it as a new genus under the name of *Ursitaxus inauritus*; but the species has long been well known in Europe. M. F. Cuvier figured, and accurately described its teeth in the "Dents des Mammiferes," so long ago as the year 1825; and the late Mr. Bennett described and figured the animal itself in 1830, from an Indian specimen then living in the menagerie of the Zoological Society.† The *Balloo-soor*, (perhaps more properly *Bhalloo-soor ?*), *Meles collaris*,‡ which M. F. Cuvier likewise elevated to the rank of a generic form, under the name of *Arctonyx*, upon the faith of a distorted native drawing sent to him by M. Duvaucel, is a real *Badger*, and was described and figured by the celebrated Bewick, at least thirty years before M. Duvaucel's visit to India. It inhabits the northern plains of Hindostan, and probably ascends the hills, but of this fact I have no certain information. Of the Gluttons, properly so called, the *Gulo nepalensis* of Mr. Hodgson, which does not differ specifically from the *Gulo orientalis* of Dr. Horsfield, the only distinction being in a lighter shade of ground colour, inhabits the

* Res. Asiat. Soc. xix., and Journal of Asiat. Soc., v. 671.

† Gard. and Menag., &c. i. 13.

‡ Penny Cyclopædia, iii. 264.

lower terraces of the hills; whilst the *Wah*, or *Chitwah* (*Ailurus fulgens*) and the *Benturong* (*Arctitis Albifrons*)* are said to be confined to the Kachar, and regions bordering on the snow-line. As regards the *Wah*, there is no doubt about the truth of the habitat here assigned to it; but the *Benturong* is a native of the Indian Archipelago, and of the Peninsula of Malacca; and I strongly suspect, that it has been confounded with some other animal, perhaps with *Paradoxurus bondar*, or some closely allied species. The habitat of *Bootan*, assigned to it in the *Regne Animal*, is altogether erroneous. Messrs. Gray and Isidore Geoffroy have proposed to consider the *Gulo nepalensis* as the type of a new genus, the former under the name of *Helictis moschata*, the latter under that of *Melogale personata*.

CARNIVORA DIGITIGRADA.

It was mentioned incidentally in the preceding article, that many species of *Carnivora* were common to India, and the Continent of Africa; and it is not a little singular, that this migration appears to have proceeded exclusively from west to east, and never in the opposite direction; or, in other words, that whilst the *Carnivora* of Africa have found their way freely into the neighbouring Continent, those of India have never passed the Arabian desert. I do not pretend to account for this. Perhaps it may depend upon the physical character of the two Continents, and the influence which this circumstance exerts in modifying the nature and habits of their respective inhabitants. The Lion of the burning Sahara, for instance, like the wild Taurick or Bedoween of the same regions, would find the parched deserts of Syria and Persia no barrier to his progress towards the East; whilst, on the other hand, the Tiger of the moist jungles of Bengal could no more pass the arid plains of Arabia than the puny and luxurious Hindoo, accustomed to the same humid soil and atmosphere. But whatever may be its cause, the fact itself is as undoubted as it is interesting. The common distribution of the *Ratel* over both Continents has been already mentioned. This animal is spread over the whole of Africa; it is common in every part of the Cape colony, and Denham and Clapperton brought it from Bornou; and though its geographical limits have not been accurately ascertained in Asia, we know that it abounds on the plains of Northern India, which do not differ much in their physical structure from the Karroos of South Africa. So

* Mr. Hodgson, in Zool. Proc., ii. 96.

likewise the Lion (*Felis Leo*), the Leopard or Panther, for they are both the same species (*Felis Pardus* and *Leopardus*), the Cheetah (*Felis jubata*), the Persian and Red-eared Lynxes (*Felis Caracal* and *Felis Chaus*), the striped Hyæna (*Hyæna virgata*), and the Jackall (*Canis aureus*), all pre-eminently African species, are found in most parts of India, without offering any striking variety either in form or colour; whilst the Tigers, Wolves, Paradoxures, &c. of the latter country have never passed far to the west of the Indus, and some of these are even without generic representation on the Continent of Africa: nor is it less singular that, as far at least as at present known, this migration should have been confined to the Carnivora. There is not a single authenticated instance of any of the numerous Antelopes in which Africa abounds above all other parts of the world, and which nature has peculiarly adapted to inhabit the most parched and arid deserts, having crossed the Isthmus of Suez, any more than of the various species of Deer so common throughout the whole extent of Asia having migrated in an opposite direction. If the various indications which Mr. Hodgson has given of the occurrence of species known to inhabit the great islands of the Indian Archipelago, and the southern extremity of the Malay Peninsula, such as the Benturong (*Arctitis albifrons*), the Malay Bear (*Ursus malayanus*), and the Javanese Ichneumon (*Herpestes javanica*), in the forests of the Turaï, which skirt the southern foot of the Himalayas, should turn out to be correct, (and it is certain that *Felis minuta* and *Gulo orientalis* are common to both these localities), it would appear that India Proper, besides its own appropriate Mammals, is a kind of neutral ground upon which the species of the most distant countries to the east and west of it meet and mingle together. One fact, abundantly singular, but which I have never seen accounted for, is the alleged total absence of every species of the genus *Canis*, so numerous and so common throughout all parts of India, in Burma, Siam, and those other countries east of the Brahmapootra, which compose the great Malay Peninsula. This is a phenomenon well worth the attention of Indian Naturalists.

As far as regards the occurrence of the *Digitigrade Carnivora* among the Himalayan Mountains, it is certain that the Lion, called *Baug* by the Indians, ascends the western hills to a very considerable elevation. Mr. Fraser often heard of it during his journey to the sources of the Ganges

and Jumna,* and Bernier, whilst travelling to Cashmere, in the train of Aurungzebe, had frequent opportunities of witnessing the chace of this animal: the amusement was reserved for the Emperor alone, and the success of a day's sport was recorded by the Imperial Historiographer in the annals of the empire. The same indifference to climate characterises the Lion in Africa; in the time of Herodotus and Aristotle, he was common among the coldest mountains of Macedon; at the present day he is as often found among the snowy peaks of the Atlas, or on the chilly slopes of the Snueuberg, as in the desert of Barca, or on the banks of the Gareip. Travellers should look for him to the east of the Brahmapootra, as though not known to inhabit any part of Eastern India, the Burmese are said to have figures which can be intended for no other animal, and which can only have been drawn from the living model. The Tiger and Leopard are well known to inhabit every part of the Himalayas, even to the line of perpetual congelation: they exist equally in Japan, in the Caucasus, and in the Altai Mountains in Southern Siberia.† The Tiger of Bockhara is less than the Bengal variety, and chiefly confined to the Valley of the Oxus;‡ whilst in Japan he is covered with a thick coat of long soft fur, to protect him from the rigours of that northern climate. The *Cheetah* is said by Mr. Hodgson§ to occur chiefly among the lower valleys of the Himalayas, but Pallas found it as far north as the Caspian Sea and the deserts of the Khirgis Tartars, so that it may possibly ascend the Hills to a greater height than has yet been suspected. Lieut. Smith mentions a small dark coloured variety of the Leopard, called *Luckur-backer*, extremely fierce, and common in every part of the Hills.

Among the smaller species of the genus *Felis*, the Moormi Cat (*Felis moormansis*) first described by Mr. Hodgson, and hitherto observed only by that gentleman, as likewise the *Felis Bengalensis* or *nepalensis*, are stated to inhabit the middle terraces of Nepal§. The *Felis Viverrinus*, first described by Mr. Bennet‖ in 1833, and three years afterwards by Mr. Hodgson, under the nearly identical name of *Felis Viverriceps*,¶ inhabits the lower terraces and valleys of the Turaï. *Felis Chaus*, (called

* I beg to observe here, that I frequently made inquiries on this subject, and could never learn anything positive on the subject; nor had any of the numerous sportsmen to whom I spoke on the subject, ever seen a Lion or its skin, obtained from within the Himalayas. At present, the Lion is I believe only found to the west of the Jumna, especially on the edge of the desert, near Hansi. J. F. R.

† Pallas Zoog. Ros., i. 16.

‡ Burnes' Travels, ii. 178.

§ Zool Proc., ii. 97.

‖ Zool. Proc., i. 68.

¶ Journal Asiat. Soc., v. 232.

Biraloo in Nepal), of which I have compared numerous African and Indian specimens, extends over every part of the Hills: it is the *Felis erythrotus* of Mr. Hodgson;* and there is a specimen of a Himalayan Cat in the Museum of the Zoological Society, so closely resembling the common Wild Cat of Europe, that it differs only in the absence of the dark transverse and longitudinal stripes which mark that species, and which may not improbably be a mere effect of locality.

Mr. Hodgson† has described three species of Paradoxuri as inhabitants of the Southern, Central, and Northern regions of Nepal respectively, two of which at least I have seen from the more Western Hills; *P. Bondar* (P. hirsutus, Hodg.) is confined to the Turaï; *P. nepalensis*, Hodg. frequents the middle ranges of the mountains, and *P. larvatus*, (P. lanigerus? Hodg.) is only found in the higher regions. Two species of Mungoos (*Herpestes*) likewise inhabit the lower terraces; *H. griseus*, called Nyool in Nepal, does not extend beyond the Turaï, but *H. Edwardsii* (H. auropunctata, Hodg.)‡ ascends the central hills; whilst *Viverra Rasse* and *indica*, and *Viverra Zibetta*, are said to frequent the same localities respectively.

The true Mustelæ, a genus proper to more northern latitudes, abound in the Himalayas, where there appear to be many different species, some of which, according to Mr. Hodgson, differ but little from those of Northern Europe and Asia. It is to be remarked, however, that they have never been properly compared; but it is interesting to find this additional instance of the relation between generic forms and climate. In the central region, besides *Mustela flavigula*, Mr. Hodgson mentions two closely allied species, one larger and of a fuller habit of body, (query, Paradoxurus larvatus?); the other, which he has described under the name of *Mustela Kathiah*, is much smaller, and often domesticated by the Nepalese for the purpose of destroying vermin, and sometimes even large animals.§ This appears to be the *Kukar* of Kemaon, where it likewise frequents the villages, burrows in the walls of houses, and is similarly protected by the inhabitants.‖ The *Mustela lanigera* of Mr. Hodgson resembles the common Weasel of Europe, but differs in its spirally twisted hair; and the same gentleman mentioned another species so nearly approaching our common Pole-cat, that he is unable to perceive any specific difference; however it will probably turn out to be distinct. Both these latter species abound in the northern and

* Journ. Asiat. Soc., v. 232.

† Asiat. Res., xix. I. 72.

‡ Zool. Proc., i. 68.

§ Journ. As. Soc., iv. 703.

‖ Asiat. Res., xvii. 16.

central regions. No fewer than seven species of Otters are said by Mr. Hodgson to inhabit the Himalayas; but they require to be carefully studied and compared, before we can venture to pronounce definitely upon their specific distinction. It is certain, indeed, that several species do actually exist in these Hills; Mr. Hodgson has himself given brief characters of four which he regards as new,* besides the two common species of the plains, (*Lutrae Nair* and *Leptonyx*), and seems to intimate that the seventh may be no more than a variety of the common European Otter.† The following is the substance of Mr. Hodgson's observations in the letter already referred to, and I give them at length in the hope that they may induce other observers to co-operate with that gentleman in filling up the sketch of which he has given an outline. "Of Lutræ we have seven species, five differing from the two usually found in the plains, as well as from all described species, except the common Otter (*L. vulgaris*), of which the largest Nepal species seems to be only a variety. It is five feet long, including the tail, and is the largest, though not the longest of our species. It is peculiar to the lower region, where also three other species inhabit: two more belong to the central, and one to the Kachar. One species is yellowish brown all over; the others brown, more or less dark, some having the chin and throat much paler than the rest of the body, and approaching nearly to white or yellow. They differ in length from five feet to one and a half feet; some being quite vermiform, and others as bulky as the Badger. Detailed descriptions, skulls, and skins of these animals, are much wanted."

Of the genus *Canis*, different species are found everywhere. The common Pariah Dog is universally dispersed through the mountains, but the Thibet Mastiff is confined to the Kachar, into which it is imported from its native country. There are many distinct varieties of this noble animal. That called *Sassa*, a large black kind, with dew claws on the hind feet, is esteemed the finest: another called *Mustang* is of a bright red colour. The common Wild Dog, called simply *Junglee Coota* in the Plains and *Buansu* in Nepal (*Canis Duckunensis* of Sykes and *C. primævas* of Hodgson) is only found in the lower regions, but is replaced farther up by two other wild species, likewise called *Junglee Coota* by English sportsmen. Lieut. Smith informs me that one of these is larger and the other smaller than the *Junglee Coota* of the Plains, from which they both differ in having shorter tails and a lighter or more ashy colour: both species ascend the Hills even to the snow line; they hunt in packs, and

* Journ. As. Soc., viii. 319.

† Letter to Zool. Soc.

inhabit ravines and rocky dells; but, being excessively shy, are not very often seen. The *Junglee Coota* of the Plains, in other respects, does not appear to me to differ from the *Canis Sumatrensis* of General Hardwicke. The *Kokree*, or small Indian fox (*Canis Corsac, Indicus, Bengalensis, Kokree, &c.*); and the *Berria*, or Wolf of India (*Canis pallipes*, Sykes), never ascend the Hills. The Jackall (*Canis aureus*), is however occasionally said to be found in the central regions; but the higher mountains are inhabited by a very beautiful species of Fox, which Dr. Royle first noticed as the Hill Fox,* and of which he brought home the first skin ever seen in England, and which was described at the time in the present memoir, and afterwards in the Proceedings of the Zoological Society, Part iv. p. 103, by the name of *Canis Himalaicus*. Mr. Pearson, then Curator of the Museum of the Asiatic Society at Calcutta, likewise described it about the same time as the latter;† and as he had a few months priority in point of publication, his name of *Canis montana* must have the preference.

The Hyæna of India (*H. Virgata*), a native of the Plains, sometimes ascends even to Simla.

RODENTIA.

The remark which was formerly made to account for our limited knowledge of the *Cheiroptera* and *Insectivora* of these mountains, may be applied with equal force to the present family; *viz*. that the comparatively diminutive size and timid habits of the animals which compose it screen them from general observation. Still we have much more detailed accounts of the Himalayan *Rodentia* than of either of the two former families, though even these are far from being so complete as could be wished.

The striped Squirrel of the Plains (*S. palmarum*) is, according to Mr. Hodgson,‡ abundant in the lower hills of Nepal; and I have seen a second species (*Sciurus Lokriah*, Hodg.) of the same size, but of a uniform earthy brown colour, tipped with golden yellow, which is said to be an inhabitant of the central regions. Mr. Hodgson mentions a third (*S. Lokroides*) similar to the latter, and perhaps not specifically distinct.§ Two beautiful species of flying Squirrel‖ (*Pteromys magnificus* and *P. alboniger*, Hodg.) are found both in the northern and central regions,

* Journ. As. Soc., i, p. 99, 1832.
† Journ. As. Soc., v. 113.
‡ Proc. Zool. Soc., ii. 98.
§ Asiat. Res., xvi. 153.
‖ Asiat. Res., xvii. 16.

but do not extend to the very elevated parts of the mountains.* Here, however, are found a small brown kind of Marmot, called *Bhia*† by the natives, hitherto undescribed; and an equally undescribed species of Rat,‡ with a tail not more than half an inch in length, most probably a Lemming (*Georychus*, Illiger), if it be not rather a *Lagomys*, of which rare and essentially arctic genus Doctor Royle has brought a beautiful specimen from the Choor Mountain. Captain Herbert, in his tour up the Valley of the Sutlej,† met with this tailless rat at an elevation of 12,000 feet, and observes that the ground was every where cut up into groves by it in search of food. He conjectures the animal to be a species of Spalax, but Dr. Royle is rather disposed to think that it was no other than the Lagomys, as he observed the ground similarly cut up in the vicinity of the spot where he obtained his specimen. The circumstance of the tail, however, which, short as it is, is expressly mentioned by both Capt. Herbert and Mr. Traill, appears to me to preclude Dr. Royle's supposition, since the Lagomys of the Himalayas, like the rest of its congeners, is absolutely without any rudiment of this organ. It is not improbable, indeed, that species of all the three genera here mentioned may be found among the more elevated ridges of the Himalayas, of which the climate is perfectly adapted to their habits: and it is to be hoped that future observers will direct their attention to the elucidation of this, as well as the numerous other unsettled points of Himalayan Mammalogy, to which I have already been so frequently obliged to refer.

Dr. Falconer, in the report of his recent journey to Cashmere and Little Thibet, mentions a Rodent under the name of the Thibet Marmot, which he says was first found in a bleak and rocky tract of country, immediately after passing to the northern slope of the great Himalayan range; but we have no farther knowledge of its characters: however, this is precisely the locality in which Mammals of this description might naturally be expected to abound. Rats and Mice, differing little, if at all, from our common European species, are abundant in all the houses. Mr. Hodgson,† indeed, expressly states that both our black and brown, or Norway rats, (*Mus Rattus* and *M. decumanus*), are the common species of Nepal, and Mr. Traill mentions them incidentally as inhabitants of the province of Kemaon. This is another interesting and important point of similarity between the Zoology of the Himalayas and that of the more northern parts of Europe and Asia; nor can we attribute the presence

* Journ. As. Soc., v. 232.

† Asiat. Res., xv. 5.

‡ Proc. Zool. Soc., ii. 98.

of these animals, in this part of the globe, to the introduction of European conquerors, as is well ascertained to have been the case in America* and Australia, since they are confined to the mountains, and altogether unknown in the Plains of India, except perhaps in some of the largest seaports. They must consequently have travelled south to reach their present habitat; and, no doubt, exist in Thibet, Tartary, and other intermediate countries, where the climate is suitable, as far as Northern Asia, from which at least one of the species (*M. decumanus*) is said to have been originally introduced into Europe. Besides these, Mr. Hodgson describes two other species (*Mus niviventur* and *M. nemorivagus*) as peculiar to the Himalayas; and I have received a Rat from Dr. Royle, which in the dried state of the specimen I cannot distinguish from the common European Campagnol (*Arvicola vulgaris*), a fact the more interesting from this genus being confined to the temperate and colder regions of the Old World. The *Bandicoot*, or great Rat of the Plains (*M. giganteus*) does not exist in Nepal;† but various kinds of Field Mice, of what precise species is not mentioned, are stated to be sufficiently common.‡ The Porcupine (*Hystrix cristata var. leucarus*, Sykes) is found in Kemaon,§ and the lower and central regions of Nepal.||

Mr. Hodgson¶ mentions two species of Hares as inhabiting Nepal. One he calls the common small species (probably the black-necked Hare of F. Cuvier, '*Lepus nigricollis*'), which, he says, is confined to the Turaï; the other, which he considers a new species, as large as the common English Hare and nearly resembling it, inhabits the higher and colder parts of the mountains. This is *probably* the red-tailed Hare of M. Isidore Geoffroy St. Hilaire,** (*L. ruficaudatus*), of which Dr. Royle obtained a specimen at Hurdwar (?) and which, he informs me, is very common in the Doon and in the neighbourhood of Delhi. As M. Is. Geoffroy's short description of this species is necessarily imperfect, from the mutilated state of the only skin which he had an opportunity of examining, the following more detailed account will not be unacceptable to the scientific Zoologist :—

The skin obtained by Dr. Royle is that of a full-grown female; it is in perfect condition, and measures one foot ten inches from the nose to the origin of the tail: the ears are about five inches in length, and the tail four inches. The face, back and sides are regularly brindled, or varie-

* Proc. Zool, Soc., ii. 98.

† Asiat. Res., xvi. 153.

‡ Richardson Faun. Bor. Amer., i. 140-1.

§ Journ. Asiat. Soc., v. 234.

|| Proc. Zool. Soc., ii. 97, 98.

¶ Traill in Asiat. Res., xvi. 153.

** Dict. Class., ix. 381.

gated with alternate wavy lines of black and light sandy brown, arising from the hairs on those parts being annulated with these two colours. The whole coat is short, smooth and glossy; it consists of a short fine internal fur, of a cottony texture, and pale bluish white colour, and of a long, coarse, external hair, which, as just observed, is annulated with black and light sandy brown, and gives the general colour to the upper parts of the body. In the distribution of these colours, each hair is divided into three equal parts, the top and bottom being black, and the centre light reddish brown. The dark colour predominates most on the face, hips, and along the median line of the back, but becomes gradually fainter upon the shoulders and flanks, and is separated from the pure white of the belly by a narrow band of pale rufous. The cheeks are grey, pointed or intermixed with black; a light grey spot occupies the space in front of each eye; the chin is also grey, and the moustaches long and stiff, black at the roots and grey at the points. The ears *appear* to be reddish brown tipped with black, but the hair has been partly rubbed off in the specimen described, which prevents me from speaking with certainty. The whole upper part of the neck is pure unmixed sandy red, the fur being of the same quality as the internal fur upon other parts of the body, and without any intermixture of the long external silky hairs. The outer face of the arms, the whole of the fore legs, and the outer face of the hind, are also red; the tail red, or rather reddish brown above, and pure white beneath; and the belly and under parts of the body unmixed white. The animal had probably been killed whilst suckling her young, as the skin exhibited four very large teats, one pair on the breast and the other on the abdomen. These were all I could observe, but there may have been more, as the skin had been a good deal rubbed about these parts.

But by far the most interesting and unexpected acquisition, which Dr. Royle's discoveries among the Himalayas has produced to the Zoologist, is a new and beautiful species of *Lagomys*, a genus heretofore only found in Northern Asia and among the rocky mountains in North America. This discovery, of the greatest importance to our inquiries into the principles which regulate the geographical distribution of animals, is entirely due to Dr. Royle, and furnishes another, and a most glaring instance of the paramount influence of climate upon the dispersion of animals, as well as vegetables. Unfortunately, the only skin which Dr. Royle has brought to England, is too imperfect to admit of so detailed a description as would be desirable. The skull has been taken out, (it is now in the Museum of University College, and, Professor Grant informs me, exhibits the same form of dentition as the other species of Lagomys des-

cribed by Drs. Pallas and Richardson), and the hind legs cut off, but in other respects it is in a sufficiently good state of preservation to enable me to assign its specific characters. I propose, under the specific denomination of *Lagomys Roylii*, to dedicate it to my friend Dr. Royle, in commemoration of the important service which that distinguished Botanist has rendered by its discovery to the kindred science of Zoology.

The *L. Roylii* more nearly resembles the *Sulgan* (*L. pusillus*, Pallas), and the American species (*L. princeps*, Richardson), than either the *Pica* or *Ogotona* (*L. alpinus* and *Ogotona* of Pallas). With the exception of the *Pica*, however, it is considerably larger than any other species of *Lagomys* : the skin here described, notwithstanding its imperfect state—for the hinder parts have been partially mutilated, measuring eight and a half inches in length, which is more than one-third as large again as the *Ogotona*, *Sulgan* or American species. From the *Ogotona*, however, it is easily distinguished by its colours, which, in that species, are light grey above and pure white beneath, as well as by its naked soles. The triangular form of the ears in *L. pusillus*, prevents that animal from being confounded with any other species, and the *Pica* (*L. alpinus*), which alone approaches the size of *L. Roylii*, is at once distinguished by the sandy red colour of its fur. The *L. princeps* of Dr. Richardson is the only remaining species of the genus at present known ; it is very similar to our animal in the colour and quality of the fur, but may be readily distinguished by its inferior size, and by the deep black hair which covers the external surface of its ears, and which is replaced in *L. Roylii* by long fur of a pure white colour.

The fur of this species is of two kinds, a very soft and fine internal one of a beautiful blue black over every part of the head and body, as well above as below, and a coarser external kind, of the same colour at the base, but afterwards marked with a broad ring of a greyish yellow colour, and finally tipped with dark brown. These two kinds of fur, however, are not produced by an actual difference in the individual hairs ; on the contrary, the same hairs exhibit both the appearances here described, being extremely soft and fine at the root, and assuming a harsh and rigid structure towards the extremity. These harsh tips, being the only parts of the fur seen from without, give their general colour to the whole body. On the upper parts of the body, the head, back and sides, this is uniform brown, slightly mixed with yellowish grey, very dark on the back, much more so, for instance, than in the common Rat (*M. Decumanus*), but rather paler on the sides, and yellowish white on the belly ; the hairs on this part wanting the harsh brown point, though in other

respects perfectly similar to those of the back. The fur on the body is about an inch in length, and nearly as long on the head, which gives the face a rough shaggy appearance. The nose is entirely covered with short harsh hair of a uniform brown colour; the upper lip is bilobed as in the Hare; the ears are of an elliptical form with regularly rounded tops, covered internally with very short brown hair, and on the outside with long white hair at the base, and short brown at the top, the posterior edges having a scarcely perceptible narrow white border. They are about half an inch broad and three quarters of an inch in length, with a small internal lobe about a quarter of an inch long, and have the folding inwards of the anterior margin, and, consequently, the resulting funnel shape of their basal portions, which Pallas noticed in the species of Northern Asia. Dr. Richardson could observe nothing of this appearance in his *L. princeps*, but I presume this must have arisen from the imperfect state of his specimens in a part so liable to be injured, since an individual in the British Museum exhibits the structure too obviously to have otherwise escaped the notice of that accurate Zoologist. The vibrissæ of *L. Roylii* are nearly as long as the head and ears together, and of a uniform brown colour. The arms and fore-arms, and, I presume, the thighs and legs, for, as I have already observed, the posterior members are wanting in the specimen, are covered with fur of the same colour and quality as that on the body, only shorter; but the whole upper face of the carpus, and probably also of the tarsus, is covered with short adpressed hair of a bright reddish yellow colour. The soles of the fore feet present four naked tubercles, corresponding to the extremities of the toes, and a fifth, considerably farther back, which represents the heel, and is separated from the others by a space covered with very short brown hair. The thumb is situated behind the other toes, and, like them, has a small sharp claw of a dusky horn colour.

Dr. Royle obtained his specimen on the Choor Mountain. I take it to be this animal which Captain Mundy* met with during his interesting tour recently published, and which he describes as something between a hare and a guinea-pig; and it is probably, also, the tailless rat which Turner† observed in Thibet, where the banks of a lake were everywhere perforated by its burrows.‡

* Tour in India, II., 196.

† Journey to Thibet, 211.

‡ I have since seen perfect specimens of this animal, but have nothing to add to the description here given.

EDENTATA.

Of this family, the only species known to inhabit the Continent of Asia, the short-tailed Manis, or Scaly Anteater of authors (*Manis pentadactyla* of Linnæus, *M. macroura* of Desmarest) is found in the lower and less elevated parts of the central regions: but all the *Edentata* are essentially inhabitants of the warmer parts of the earth, more especially of tropical America, and we cannot therefore expect to find their forms reproduced in the Himalayas. Mr. Hodgson has described the Manis of Nepal as a new species, under the name of *M. auritus*,* on the supposition of its being distinct from the common species of the plains of Upper India, the *Badjarkita* of the Bengalese (*M. macroura*), which has been known ever since the expedition of Alexander the Great, and is mentioned by Ælian under the name of Φατταγης; but Mr. Hodgson in this, as in many other instances, has been misled by Griffith's Translation of the *Regne Animal*, a compilation which has obtained a much greater authority in India than its merits entitle it to, or than it enjoys at home.

PACHYDERMATA.

The great Saul Forest, which extends for many hundred miles along the bases of the Himalayan Mountains, affords shelter to vast multitudes of animals, of which it is probable that many species still remain undescribed. Among other genera, the large *Pachydermata* abound in these situations; the Elephant and Rhinoceros (*Elephas indicus* and *Rhinoceros unicornis*), are extremely numerous; and in the rainy season, or in times of scarcity, make frequent inroads into the lower hills, and commit great depredations among the crops of the natives. The Indian Rhinoceros affords a remarkable instance of the obstructions which the progress of knowledge may suffer, and the gross absurdities which not unfrequently result from the wrong application of a name. This animal, to whose horn the superstition of the Persians and Arabs has in all ages attributed peculiar virtues, became known to the Greeks through the description of Ctesias, a credulous physician of that nation, who appears to have resided at the court of Persia in the time of the younger Cyrus, about 400 years before the birth of Christ. His account, though mixed up with a great deal of credulous absurdity, contains a very tolerable and perfectly recognizable description of the Rhinoceros, under the ridiculous name, however, of the *Indian Ass;* and as he attributed to it a whole hoof,

* Journ. As. Soc., V. 234.

like the horse, and a single horn in the forehead, speculation required but one step further to produce the fabulous Unicorn, such as it appears in the royal arms of England, and such as it has retained its hold on popular credulity for the last two thousand years. The works of Ctesias have perished, but this curious passage is preserved by Phocius;* Aristotle† adopted his statements regarding the *Indian Ass*, from Ctesias; and no other passage of his writings has given rise to a tenth part of the commentaries, discussions, and speculations which have originated in this. Religion was, as usual, pressed into the discussion, and as the Septuagint had used the word *Monoceros*, it was at one time next to rank heresy to doubt the existence of the Unicorn, and might have brought the imprudent sceptic to the stake. But it is not my intention to renew this fruitless and childish discussion; my only wish is to point out the perfect applicability of Ctesias's description to the Indian Rhinoceros, as it is now well known to naturalists; those who wish to pursue a subject of considerable interest in the history of human knowledge, will find many curious details in the writings of the learned Bochart,‡ in Scaliger, Hardouin, Sivry, and others of the older commentators on Aristotle and Pliny.

Wild Hogs, but of a smaller variety than those of Bengal, are extremely numerous in all the wooded parts of the mountains; they do not appear to be specifically different from the common wild boar of Europe. Horses do not breed on the southern face of the mountains, but are imported from Thibet.§ A valuable and sure-footed variety, called Tangun, is described by Turner.‖ The Ass does not appear to have been introduced into any part of the mountains, at least neither Dr. Hamilton nor Mr. Hodgson makes any allusion to its being found in Nepal,¶ and Mr. Traill expressly states that it does not exist in Kemaon.** The Dziggetai, however (*Equus hemionus*), is found on the plains of Thibet and Tartary, and is called *Kiang* by the natives.

RUMINANTIA.

The Ruminantia of the Himalayas, as composed of the larger four-footed game most commonly followed by sportsmen, are probably better known than any other department of Hill Mammalogy. Yet even here much still remains to be done to make us thoroughly acquainted with all the different species or varieties which have been mentioned by Mr. Hodg-

* Photii Biblioth. cod., 72, p. 91.
† Hist., lib. ii., c. 1.
‡ Hierozoï, lib. iii., c. 26.
§ Mundy's Tour. ii., 75.
‖ Fraser's Journey, p. 351.
¶ Hamilton's Nepaul, 79.
** Journey, 21.

son* and other writers; the nomenclature, in particular, is extremely confused, and there is strong reason to believe that the number of species, particularly among the deer tribe, has been greatly increased by the variety of names given to the same animal in the ever varying dialects of the hill tribes. I have, however, only mentioned those of which the existence is known with some degree of certainty.

The Musk (*Moschus moschiferus*), called Kastooree, is not uncommon in the higher hills. It is said to derive its peculiar odoriferous secretion from feeding on the Kastooree plant, a kind of ground nut, which is strongly impregnated with the same pungent scent, and which the animal digs up with its long tusk. Mr. Hodgson, in a recent number of the Journal of the Asiatic Society,† expresses his belief in the existence of three different species of this animal among the Himalayas, and even assigns them distinct names; but the characters are founded entirely on the difference of colour, which is too variable to be depended on for the purpose of specific distinction; and, in fact, Lieut. Smith assures me that the colours vary with the age of the animal; a remark on which I am disposed to place the greater reliance from its agreeing with my own observations, made on many individuals preserved in the museums of this country and the Continent. Whether the "Second species of Musk," mentioned by Dr. Falconer as having been discovered during his recent journey into Cashmere and Little Thibet, be founded on more important characters, we have no means of ascertaining, that Naturalist not having yet published his observations.

Of the genus Cervus, the Chittra or Spotted Axis (*C. axis*), and the Laguna or Pâra and Sûgoriah, called also *Jhou Laghuna* and *Khar Laguna*, or spotted and brown varieties of the Hog-deer (*C. porcinus*) are common in the lower hills and forests, but do not ascend the mountains. The specific distinction or identity of the two latter animals has long been a subject of dispute among naturalists; Lieut. Smith believes that the spotted variety is only the young; but I have myself seen animals at least three or four years old, with a row of spots on each side of the spine, though, at the same time, I do not believe them to be distinct from the plain coloured or common brown variety, with which they perfectly agreed in every other respect. The subject is worth the attention of those who have an opportunity of settling the question. Three other species of the Axine group of deer are mentioned by Mr. Hodgson, under the collective name of Jaraï, but individually distinguished by the Nepalese as the Phûsro, Râto, and Kâlo, or hoary, red, and black Jaraïs res-

* Asiat. Res., xvi., 351. † New Series, I., 202.

pectively. The two former have been identified with the *Cervus Hippelaphus* and *Cervus equinus* of Cuvier, the latter certainly without foundation, and the former at least very doubtful; the third, said to be undescribed, is probably the *C. Aristotelis* of Cuvier; but the truth is, that we know very little about them, nor are these different species mentioned by any other author besides Mr. Hodgson. The *Cervus Hippelaphus*, indeed, called *Saumer* or *Sambre* in the Plains, is well known in this country, where he has long existed in our menageries, and is probably the *C. Aristotelis*, which is familiarly called *Elk* in the Hills, and of which the native name in the British hill provinces is *Jerow* for the male, and *Maha* for the female, names which have been not unfrequently applied to different species; of the Phûsro, or Hoary Jarai of Mr. Hodgson, which, whatever else it may be, is certainly not the *C. equinus*, since that species does not inhabit Continental India, nothing is known but the name, if, indeed, it be not a mere variety of sex or age. Lieut. Smith describes the Jerow of the Hills as a larger and heavier animal, and with finer horns, than the Saumer of the Plains: the tan and black colours of these two species appears to identify them with the Râto and Kâlo Jaraïs of Mr. Hodgson.

No fewer than three species of deer, with characters approaching to those of the common stag (*C. Elaphus*) of Europe, have been mentioned as inhabitants of Nepal. Two of these, the *Cervus Wallichii* and *Cervus Duvaucellii* of Cuvier, are known, though not so perfectly as could be wished; the third, which has been identified with the common stag, appears to be founded upon error. Mr. Hodgson has briefly described the *Cervus Duvaucellii* under the name of *C. Elaphoïdes*, and I have seen a full-grown male in the Zoological Gardens; the comparison of the skull figured by Mr. Hodgson* with the horns in the *Ossemens Fossiles* leaves no doubt as to the identity of the species. It is called in Nepal *Baraïyo*, and, according to Mr. Hodgson, *Maha* in the Western Hills, a name which, as observed above, Lieut. Smith applies to the female Jerow. *Cervus Wallichii*, called *Barah Singha*, is mentioned by Mr. Walter† as an inhabitant of the mountains of Silhet, and by Mr. Hodgson,‡ who confounds it with the common stag, as found in the Saul Forest, which skirts the foot of the Nepal Mountains, whence it was originally sent to Calcutta by Dr. Wallich. There is no grounds for supposing the existence of a third species of this group in the Himalayas, identical with the Red Deer of Europe (*C. Elaphus*), though the

* Journ. Roy. As. Soc., IV., 648. † Asiat. Res., xvii., 499. ‡ Loc. Cit.

fact is distinctly stated both by Duvaucel and Mr. Hodgson :* these authors appear to have mistaken the *C. Wallichii* for that animal, though the specific distinction was afterwards well known to Duvaucel, who sent to Baron Cuvier the description published in the "Ossemens Fossiles." Dr. Falconer mentions the discovery of a new species of deer in the Report of his recent Journey to Cashmere and Little Thibet,† and Dr. Royle has figured (tab. 5, fig. 1) a female under the name of *C. Dodur*, by which it is known about Saharunpore. He describes it as being about the size of the female Hirn (*Antilope cervicapra*), lighter and more graceful than the Hog-deer, and of an ashy brown colour; but this is all I know of the animal, nor do I find it even mentioned by any other writer. It appears to be unquestionably a new species, and is well worth the attention of Indian naturalists.

Of the *Muntjac* tribe of deer, I am acquainted with three distinct species inhabiting the Indian continent: one entirely black (*C. melas*), one of a light sandy fawn colour, probably the *Ratwa* of the Nepalese (*C. ratwa*, Hodg.), and the third the common Muntjac, called Kacker by the natives, and Barking Deer by the Europeans (*C. Muntjac*, Lin.), of a deeper bay and much smaller size than the *Ratwa*: the former is scarcely the size of the Roe-buck (*C. Capreolus*); the latter nearly equals the Fallow Deer (*C. Dama*, Lin.). Dr. Royle has figured the "Barking Deer" of the North Western Himalayas, v. tab. 5, fig. 2, under the name of *Cervus Rutwa*, conceiving it to be identical with Mr. Hodgson's species. All these animals may be readily distinguished from the other species of Deer, by their long projecting tusks, horns mounted upon long bony pedicles, and the glandular folds of skin on the forehead. They require, however, to be more attentively examined, and compared with one another.

Of *Hollow-horned* Ruminants, the *Ghoral* and *Thar* (*Antilope Ghoral* and *A. Thar*), are now pretty well known from the researches of Mr. Hodgson, who has set a praiseworthy example to our Indian countrymen, by the laudable zeal with which he perseveres in illustrating the Zoology of Nepal. Both these species are proper to the middle and northern regions of the Hills. The Thar of Mr. Hodgson is universally called *Surow* and *Imoo* in the more western parts of the mountains, the latter name predominating in the higher, and the former, in the lower hills: the name of Thar, according to Lieut. Smith, is there applied exclusively to the species of goat which Mr. Hodgson calls the *Jharal*. That beautiful and stately antelope, the *Chiru* (*A. Hodgsonii*), of which our

* Asiat. Reg., xv., 120. † Journ. Asiat. Soc., iv., 710.

knowledge is entirely due to Mr. Hodgson's researches, is confined to Bhot, Thibet, and the surrounding countries; it appears to be altogether unknown on the southern face of the Mountains, except from an occasional specimen imported by the traders, either for presents or barter. The common Indian antelope, called *Hirn*, and the *Chickarra*, or four-horned species (*A. cervicapra* and *quadricornis*), are confined to the lower hills and forests, and the *Neel-ghau* (*A. picta*) principally to the plains and jungles of the north-western districts. Mr. Colebrooke says that, in the opinion of the Hindoos, the resort of the Antelope sanctfiies the countries graced by his presence, while his absence degrades the regions which he avoids. This seems more connected with physical observation than with popular prejudice. The wide and open range in which the Antelope delights is equally denied by the forests of the mountain and by the inundation of the fens.* These are the only antelopes of which we have any precise knowledge, as inhabitants of this part of India; but it is probable that others still remain undescribed. Captain Herbert,† in his "Tour to the Sutlej," mentions two animals by the names of *Skin* and *War*, the accounts of which do not agree with any known species, and which are therefore well worth the attention of future observers. The *War*, according to Capt. Herbert, is somewhat like the *Musk Deer* (*Moschus Moschiferus*), but with a face more like that of a sheep, divided hoofs, and horns more nearly resembling those of a buffalo than of any other animal; a description which, in spite of the similarity of names, is inapplicable either to the Thar or Jharal, though indeed, little dependence is to be placed in the descriptions of unscientific observers.

The *Neel-ghau* deserves a more particular notice, for the purpose of clearing up a point in its history, equally interesting to the Classical Scholar and to the Zoologist. It has been already observed that Modern Naturalists, after the example of Baron Cuvier, have identified the great *Saumer Deer* of India with the animal which Aristotle describes by the name of *Hippelaphus*. "The *Hippelaphus*," says the Greek philosopher,‡ "has also a mane, (he is talking of the mane of the Horse), above the shoulders, but from this to the head along the top of the neck *it is very thin*; it has likewise a *beard on the larynx*;......it is about the size of the Stag......the female has no horns......those of the male resemble the horns of the *Dorcas* (*A. Gazelle*)......it inhabits Arachosia."

* Colebrooke on Bengal Husbandry. † Asiat. Res., xv., 397.
‡ Hist. lib. II. c. 5.

Any one acquainted with the *Neel-ghau* will readily perceive the applicability of this passage to its most obvious characters: in fact Aristotle's description of this animal, under the name of *Hippelaphus*, is more exact and minute than the description of any other animal mentioned in his history; it is evidently taken from personal observation, and it is surprising that the application should have hitherto escaped the penetration both of critics and Zoologists. The older naturalists, such as Gesner and Aldrovandus may be excused for misapplying the passage in question, sometimes to the Elk, sometimes to the common Stag in his winter-dress, when the hair of the neck becomes longer than ordinary, since they were unacquainted with the form and characters of the *Neel-ghau;* but the continuation of the mistake by their successors, to whom the animal has been long familiar, is altogether unpardonable. This identification, indeed, was absurd enough from the beginning: the habitat of Arachosia, and the assigned form of the horns, were alone sufficient to distinguish the Hippelaphus from either the Elk or common Stag, independently of the critical absurdity of supposing Aristotle to describe such well-known animals at such length and under a new name: but the truth is, that all modern commentators have been misled by a wrong translation of the term Δορκας, employed by Aristotle, as the name of an animal, to the horns of which he compares those of the Hippelaphus. Now, it is to be observed that the Dorcas of the Greeks and Romans is universally admitted to be the Gazelle of Egypt and Northern Africa, as may be easily proved from many passages in Herodotus and other ancient writers. Theodore Gaza, himself a Greek, and the first translator of Aristotle, very properly renders the word by *capra*, but Buffon* having criticised Gaza's *ignorance*, and affirmed that the word should really be translated *caprea*, every body has since followed the translation of Buffon, and the *Dorcas* of Aristotle has been accordingly considered identical with the *Roe-buck*, whilst the *Dorcas* of all other ancient writers is acknowledged to be the *Gazelle*.

This seems to have been one of the principal sources of error which misled Baron Cuvier, after the example of his predecessors, to identify the Hippelaphus of Aristotle with a species of Deer. The head and skin of the large Indian *Saumer* had been sent to Paris by Diard and Duvaucel; the hair of the neck was observed to be considerably longer and coarser than that on the rest of the body, the horns had only two antlers, *like those of the Roe-buck*, and it came from India. Baron Cuvier immediately concluded that he had discovered the real Hippelaphus of

* Hist. Nat. XI. 402.

Aristotle, and takes considerable pains to prove it.* Against this opinion of the most distinguished of modern naturalists, however, I have to urge objections as grave as those which lay against the ancient error which identified the *Hippelaphus* with the Stag and Elk. In the first place, as I have just shown, the fancied similarity of the horns of the *Hippelaphus* to those of the Roe-buck, arises from a false translation of the word *Dorcas;* when this term is properly translated, *Gazelle*, the horns of the *Hippelaphus*, to be similar to those of the *Dorcas*, should be small, round, and *without branches;*—such are the horns of *Neel-ghau,* and such are not the horns of the Saumer. In the second place, the *Saumer* Deer has certainly longer and stiffer hair on the neck than elsewhere, but it is equally long and rough *over the whole neck, as well on the sides as above and below*, and has no resemblance whatever to the mane of the Horse and Mule to which Aristotle compares it. In fact the description of Aristotle does not apply to it in any particular. *The Saumer* does not show the least appearance of the *thin mane along the top of the neck, longest and thickest on the shoulders;* neither has it anything that can be called a beard, distinct, at least from the general roughness of the neck which Baron Cuvier calls its mane. But even allowing the rough hair on the under surface to be called a beard, still Aristotle's description does not apply, for this rough hair covers the *whole throat* in the Saumer from the head to the chest, whilst the Greek philosopher restricts the beard of the *Hippelaphus* to the *Larynx*, and this is precisely the situation in which the long bunch of coarse hair, nearly a foot in length, is found on the throat of the *Neel-ghau.* In fact there is not a single point, even to the most minute particular, the habitat of Arachosia, for instance, the modern Punjab, where the Neel-ghau is extremely abundant, and where the Saumer does not exist, at least we have no evidence of the fact,—in which Aristotle's description of the Hippelaphus does not perfectly agree with this now well-known animal; and we may therefore safely conclude that we have at length finally settled a question which has long puzzled both critics and Zoologists. The *Neel-ghau* should consequently assume in future the specific appellation of *Antilope Hippelaphus*, whilst the Saumer Deer, to which that name has been erroneously applied, may be more appropriately called *Cervus Saumer.*

Two distinct species of the genus Capra occur in the Himalayas: *Capra jemblaïca* of Hamilton Smith, called *Jharal* in Nepal, and *Thar* in the British provinces, is by far the more common of the two, and is

* Oss. Foss. IV. 42.

stated by Mr. Hodgson* to differ from other goats by having four teats. The second species has never been described, but its existence is placed beyond a doubt; Major Kennedy, while resident at Simla, had two stuffed specimens, procured in the neighbouring mountains, and the animal is mentioned by various tourists under the name of the Ibex, which it appears to resemble in the form of the horns and other characters. Dr. Falconer, in the Report of his late Journey to Cashmere and Little Thibet, mentions the discovery of two new species of goats; but as he does not enter into any detail on the subject, we have no means of ascertaining how far they may prove to be identical with, or different from, the two species here mentioned. Different varieties of the domestic goat, the most valuable of which are the *Changra*, or shawl goats, of two breeds, distinguished as the larger and the smaller Changra, are found in the more alpine regions; their wool forms an article of extensive traffic, but we are much in want of detailed comparative descriptions and good figures of these, as of all the different breeds of cattle and other domestic animals in India; a subject of great interest, which has been extensively illustrated at home, but which has met with little or no attention out of Europe.

Of sheep there are likewise two wild species, and numerous domestic varieties, found in these mountains. The *Burrhal*, called *Nahoor* by the Nepalese (*Ovis Nahoor* of Mr. Hodgson), is intermediate in character between the Mouflon (*O. Musmon*) of Corsica, the supposed parent of our domestic sheep, and the Aoudad (*O. tragelaphus*) of Northern Africa, which latter species it resembles in the form of the horns and the absence of the crumens, or tear-pits, which distinguish the rest of the genus. The second species, called *Banbhera* in Nepal, is less known, but appears to approach very nearly to the Argali of Siberia (*O. Ammon*), if, indeed, it be not identical with that animal. I have seen the skull and horns in the Museum of the Royal Asiatic Society, to which it was presented by Sir Alexander Burnes; but as there is no specimen of the Argali in this country with which to compare it, I can offer no opinion as to its specific difference. The animal seems to be more properly a native of Thibet and Chinese Tartary, and seldom appears on the southern part of the Himalayas; at least none of my sporting acquaintances ever met with it, and Mr. Hodgson was long doubtful of its existence. Of the domestic sheep of the Hills, besides the Dûmba, or common variety of Upper India, Mr. Hodgson mentions a breed called *Barwal* as occurring in the Kachar, and another called *Hoaniah*, peculiar to Thibet: these are used as beasts

* Journ. Asiat. Soc., iv. 710.

of burden for carrying grain and other products across the mountains, but we know little of their peculiar forms or qualities.

Of the genus *Bos*, the buffalo (*B. Bubalus*), and its representative, the *Arnee*, or *Urnee Bhinse*, are confined to the sultry forests at the foot of the mountains. The latter is a very distinct variety, if not a different species, from the *Junglee Bhinse* of Bengal and Assam, so well known for the great length of its horns; the *Arnee* of the Saul forest is the short thick horned variety, of which there are many skulls, preserved in our Museums, and is said to be a much lighter made animal, though with a thicker skin than the *Junglee Bhinse*. The Zebu (*Bos indicus*) is common in every part of the Hills; but the peculiar and appropriate species of the Himalayas is the Changree, or Yak (*Bos pœphagus*, Pallas), which composes the domestic cattle of Tartary, and is not uncommon on the southern slopes of the higher Mountains, where a cross between it and the Zebu, or common Indian Ox, is much used in agriculture, and preferred to either of the pure races. This hybrid is not uncommon at Simla, and it is to be hoped that some intelligent observer will take advantage of this circumstance to ascertain from actual experiments whether the sexes be productive *inter se*, or when united with one of the pure races; or whether, like the common mule, they be absolutely barren. Lieut. Smith informs me that he has seen the Yak wild on the confines of Chinese Tartary.—*Royle's Illustrations of the Botany, &c. of the Himalayan Mountains, Supplementary Part.*

ART. X.—*Beryl Mine of Paddioor, and Geognostic Position of this Gem, in Coimbatoor, Southern India.—By* Lieut. NEWBOLD, *Madras Army, A. D. C. to* Brigadier-General WILSON, C.B.

The Beryl mine of Paddioor, or Patialey as it is sometimes termed, is situated at the eastern extremity of a village of the same name, in the Kanghyum Taluk, in the Coimbatoor Collectorate, about forty miles E.N.E. from the town of Coimbatoor, which lies in Lat. 11° N., and Long. 77° 1′ E. The surrounding country is an undulating plain, studded with a few short clusters of hills, principally of gneiss and quartz rock. The surface of the plain is intersected by a few ravines and rivulets, flowing towards the Noel river, which, rising in the Nilgherry Chain, pursues an easterly course to the Cauvery. The latter river flows through the midst of this great plain, which is bounded by the Nilgherries to the west, and

the Shevaroy and Salem Mountains to the east. All these ranges consist of normal rocks, principally gneiss, hornblende-slate, and mica-slate, associated with granite, greenstone, and basalt in dykes. The rocks that occur in the plain are of a similar description, with beds of quartz distinctly stratified, sometimes highly ferruginous, and passing into garnet rock. Garnets, regularly crystallized, often occur in the gneiss and hornblende slate. Primitive crystalline limestone and a talcose rock occur, though rarely, interstratified with the gneiss and hornblende slate. A remarkable feature is the prevalence of basaltic dykes, accompanied by large travertine and tufa-like deposits of carbonate of lime. The influence exerted by these dykes over crystalline and metalliferous developments in these districts is interesting and instructive. Dykes, or veins, of a porphyritic granite too, traverse the gneiss in various directions. The larger veins are generally from W. to E., varying a few degrees to the S. of E. The metallic ores and minerals found associated with these rocks are chiefly the magnetic or black iron ore, disseminated and interstratified with quartz rock in a state of great purity. It sometimes occurs in octahedral crystals, with a whitish micaceous looking *enduit.* Both varieties are often highly magnetic with polarity. Manganese also occurs in the form of the black oxide; also garnets, corundum, magnesite, nephrite, asbestus, chromate of iron, adularia, pyrites, &c. Rubies have been found associated with the corundum which occurs imbedded in gneiss. I am not aware that the other beautiful variety of rhomboidal corundum, viz. the sapphire, has ever been discovered; but, from certain indications, I should be led to suppose its existence. Gold-dust is found in many of the rivulets flowing down the sides of the Nilgherry and Salem Mountains.

I will now proceed to describe the bed, and minerals with which the Beryl is more immediately associated in the particular locality which has already been adverted to, viz. Paddioor. The mine has been sunk through a bed or dyke in the gneiss and mica-slate on the line of contact; it is about eighteen paces long, by fourteen broad; it has about seven feet of water covering the lower part, and is about twenty-four deep to the surface of the water. The dyke is composed of a highly crystalline porphyritic granite, the component minerals of which are generally beautifully characteristic and distinct. The quartz is sometimes regularly crystallized, but usually in amorphous translucent masses, imbedded in large tabular crystals of pale rose-coloured felspar, with cleavlandite, garnet, and white, black, and bottle-green mica. A crystallized pyramidal prism of quartz that had been dug out of this mine measured 2 feet 3½ inches in length, and 1 foot 3 inches in diameter; it had, however, been fractured, and four only of the sides were tolerably perfect. The

mica occurred both in six-sided tables and in large irregularly-shaped nests, one of which measured 2 feet in length; the laminæ highly elastic and transparent. A few of the garnets were crystallized in dodecahedrons, sparingly disseminated in the rock; one of these crystals measured 2 inches in diameter. The crystals of cleavlandite were remarkably fine, and characteristic of this beautiful variety of felspar. The various minerals composing this bed pass from the porphyritic structure into a curiously fibrous arrangement: the quartz, felspar, and cleavlandite occurring in alternate prismatic laminæ; sections of this rock, at right angles with the long axis of the prisms, exhibit on their surfaces the appearance of graphic granite. Where this arrangement is observed, the mica is partially and irregularly distributed in thin pyramidal nests, rarely in direction with the laminæ of the rock. The quartz and felspar, where they meet with a large nest of mica, usually lose their laminar structure, becoming confused and lumpy. The felspar and cleavlandite is both white and translucent, and opaque and reddish; the latter is often crossed by microscopic fissures, inclined at a great angle to the axis of the prism. Ghunpore, in the Nizam's dominions, is the only other locality in India where I have met with this fibrous rock; it was there also associated with gneiss and granite. The cleavlandite often occur in large masses, with small cavities partly formed by the decomposition of the rock, and partly by the intersection of the longer and more distinct crystals of the cleavlandite; it is in this gangue, and in these cavities, that the Beryl, or aquamarine, is almost invariably found, in long deeply striated hexahedral prisms, with small crystals of quartz.

The whole of the rock, composing the dyke, is divided by seams, almost horizontal, intersected by fissures, thus dividing it into cuboidal masses. Many of the seams are filled by a whitish earthy incrustation of carbonate of lime, that has a tendency to collect in nodules. The larger calcareous veins attenuate as they ascend in the rock, and appear to have penetrated it from below, rather than to have been deposited from above. On reaching the surface, which it often overspreads, in beds of great extent, underlying the present soil, it assumes a closer texture, with a nodular or pisiform surface, the interior having a spheroidal structure, not unfrequently assimilating that of the travertine of San Filippo. It has been deposited, no doubt, by springs of water ascending through the subjacent strata, charged with carbonic acid, and holding lime in solution.

Small springs are still observed percolating upwards through the fissures of the rock; and, as they trickle over its surface, depositing a thin black crust composed of carbon, a little iron, calcareous and saline

matter; the latter contained both the muriate and sulphate of soda; which salts, and nitrate of potass exist abundantly in the soil of the adjacent district. The water at the bottom of the mine is sufficiently pure for irrigation and the purposes of life.

There are marks of other excavations in this vicinity, and in the same bed. The natives, however, assert their perfect ignorance of their use. Judging from the high barren situation in which I found them, these excavations could hardly have been made for wells. Blocks of the cleavlandite, which forms the matrix of the gem, had been thrown out, and evidently broken up in search of what it might be supposed to contain. The excavations were shallow, but extensive, and the quantity of the broken up gangue very large; it (the cleavlandite) can be traced in the rocks in the vicinity to an extent, east and west, of about thirty-eight miles; and it is likely that, in ancient times, antecedent to Mahomedan conquest, when rights to landed property were more secure, the gem was obtained in abundance. Now, the surface veins appear to be completely exhausted in all the excavations I examined; but it is probable, from the inquiries I made, that it is still secretly procured by natives from certain localities in this district, as it still forms an article of traffic in Indian bazaars. It has been thought, with some reason, that the largest crystallized Beryl ever known, weighing six ounces, and costing £500, and which was supposed to have been brought to Europe from Ceylon, was the produce of the Beryl mines of Coimbatoor, as neither Davy, nor any of the authors conversant with the mineralogy of Ceylon, mention its existence on that island. It has been stated positively that it does not occur there.

To Mr. Heath the merit is due of having first brought these mines under the notice of government. Mr. Fischer, the enterprising land-proprietor of Salem, informed me that the gem was first discovered by the diggers of a well on the estate of the village Potail, who sold them secretly to the itinerant jewellers and chittys, who purchased them in large quantities for a mere trifle, and sold them at an immense profit at Madras, Pondicherry, and other European settlements. This, coming to Mr. Heath's knowledge, afforded a clue by which he was enabled to trace the beryl to its situs. He lost no time in obtaining the conditional consent of government, and arranging with the native owner of the land. Mining operations were carried on for about two years, and were discontinued in consequence of the mines being exhausted, and the expense of draining off the water. It has now (1840) reverted to its original purpose of irrigation, and is still the property of the Potail who originally caused it to be dug. This venerable old Hindoo, Chin-

nana Gouda, whose hair and beard are blanched by age, paid me a visit at the mine. He informed me that it is upwards of forty years ago since he dug it; and that, until Mr Heath's discovery, about twenty-two years ago, he had not the slightest idea of the treasures contained in his own well, and of which he had been robbed for eighteen years by the people he employed.

In India, the beryl appears to be almost confined to this particular district. The natives, however, inform me that it occurs at Vaniambadi, at the northern base of the Nilgherries, in rocks of a similar age and petrographical character. In Europe it occurs also in the primitive rocks—in the granite and gneiss formations.—*Edinburgh New Philosophical Journal, October* 1840—*January* 1841.

XI.—*On the Functions of the Colouring Matter of the Skin in the Dark Races of Mankind.—By* Robert Mortimer Glover, M. D., Lecturer on Chemistry in the Newcastle-on-Tyne School of Medicine.

Various hints and hypotheses have been put forth as to the functions performed by the peculiar organization of the skin in the dark races of mankind. The opinions of Sir Everard Home, published in the Philosophical Transactions for 1821, have been generally adopted by physiologists as apparently founded on a methodical attempt to investigate the subject by direct experiment, and to elucidate it by analogical reasoning. The experiments of Sir Everard give results certainly quite opposed to what has been determined by physical observers respecting the laws which affect the radiation from, and absorption of, heat by coloured surfaces. This circumstance drew my attention to the subject, and led me to repeat some of the experiments related by Sir Everard.

It may be mentioned, before entering on the subject, that this inquiry was proposed by Lord Bacon.

The structure of the skin and of its layers is yet involved in some doubt as to many particulars; but so far as our inquiry is concerned there is no doubt whatever. It is clear that there is a spongy or vascular layer between the cuticle and true skin; or on the surface of the latter, constituting a portion of it. It is also certain that the colouring matter of the skin resides in this region. And that the intensity of shade is the greater or less abundance of the colouring matter. Hence the European

and the Negro furnish extreme instances in this inquiry; since in the one the colouring matter is in small quantity or of light shade, whereas the other has it so abundantly that in him we speak of the *pigmentum nigrum*. Between these extremes exist many curious varieties, in whom the functions of the colouring matter are well worthy of consideration, but we have data to reason only with regard to the European or White, and the Negro. Indeed, in many of the coloured races, the existence of something analogous to the dark pigment is only inferred, although the occurrence of Albinoes in all races should induce us to believe the presence of a pigment universal. So that what is said of the colouring matter in the Negro may be extended to all varieties of colour, reasoning by analogy.

It is scarcely possible to regard the dark colouring matter otherwise than as a provision for, in some way, enabling those who possess it in abundance to withstand the heat of the climate they inhabit. Accordingly, there are facts which prove such individuals to be more capable of withstanding the heat of torrid regions than acclimatized Europeans, or other whites born there. There are also facts to connect this power of withstanding excessive heat with the development of the dark colouring matter. Thus, Albinoes of Guinea, differing from both Europeans and their countrymen in this, that they totally want the colouring matter, according to many authors, are even less capable of resisting the heat of their native country than European strangers; indeed their skins are said to crack and blister on exposure to the sun's rays. And I am informed by Mr. Granidge of Barbadoes, that he has observed the same fact in that island.

Now, when we reflect that the European cannot be without some colouring matter between the true skin and cuticle, since he must differ in this respect from the Albino, it seems as if a relation were established between the development of the pigment, and probably of the rete mucosum along with it, and the power of resisting the sun's heat in torrid regions.

It is clear that in this inquiry we should regard, not merely the physical properties of the organization we consider, nor its vital properties only, but the action and reaction of the whole, and their effect on the system of the individual. For want of a consideration of all circumstances, before the publication of Sir Everard Home's views, it was not conceived how the tint, which, on analogy, should absorb more heat than any other, could, in the hottest regions of the earth, confer any exemption on its possessor. And perhaps before this paper is concluded, it

may be apparent that, since Sir Everard published, the matter has been misunderstood.

The notions entertained at present by physiologists, with regard to the operation of this pigment, are implicitly those of Sir Everard. And what they are, will appear from the following brief quotation from an elementary work:—"The secretion on the cutis vera, which gives the black colour to the skin, appears to assist in fitting men for residence in hot climates, because although such skin, by absorbing more caloric, rises to a higher temperature under the sun's rays than white skin does, yet it does not inflame so readily from a rise of temperature." Dr. Alison's meaning is, that although the skin of a negro may rise to a higher temperature under the sun's rays than a white skin in the same circumstances, yet the dark skin is less likely to inflame at *that higher temperature* than the white skin at *that lower one.* This, then, is the conclusion of Sir Everard Home, whose paper I now proceed to examine.

The paper of Sir Everard Home contains alleged facts and experiments, tending to prove the Negro more capable of withstanding excessive heat of the sun's rays than the white man, and attributing this to a supposed property in dark surfaces of destroying the scorching and blistering effect of the sun's rays. The former conclusion has already been admitted. The facts by which Sir Everard supports his second position are to be considered.

Sir Everard having fallen asleep on the deck of a vessel exposed to a tropical sun, found, on awaking, his thigh scorched through a pair of *thin* white linen trousers. From this simple observation, the extravagant conclusion is drawn of black being a better protection against the sun's rays than white.

An experiment is next related, in which Sir Everard found, on exposing his hand to the sun's rays for 45 minutes, while a thermometer attached to it stood at 90°, that blisters rose and coagulated lymph was exuded. I have attempted to produce the same effect by the concentrated rays of the sun at the same temperature indicated in a similar way, and kept up to within one or two minutes of the time, when my patience was exhausted, without any result except slight reddening. Six years ago, while off the coast of Algiers, I sat for half an hour immoveable in the sun, having the greater part of my face exposed, the thermometer in the sun's rays being considerably above 100°, and though my face was scorched, nothing like the effect described by Sir Everard took place.

Sir Everard next attempted to compare the inflaming and blistering power of the sun's rays with that of hot water. He says, that water at the temperature of 120° was painful to the body, and became unbearable

when still further heated. From this experiment and the preceding, he wishes us to infer a power of vesicating in the sun's rays not in proportion to their temperature.

In a third experiment, he exposed the backs of his hands to the sun with a thermometer on each, the one hand being uncovered, while the other had a covering of black cloth under which the thermometer was placed. After ten minutes, the degree of heat on each was marked, and the state of the surface examined, and this was repeated three times. During the last trial, the thermometer which had its ball covered by the cloth stood at 106,° while the other was at 98.° The exposed hand was scorched, that covered was unaffected in all the trials. I have not repeated this experiment because it is subject to an obvious fallacy, for the ball of the thermometer being between the cloth and the part, a space intervened, and across this space the heat from the cloth could only pass by radiation or by transmission through the thermometer, but not directly from the cloth to the hand, so that the heat might not accumulate on the skin.

In a fourth experiment, a Negro bore the sun's rays on his hand when a thermometer on the part indicated 100° without any scorching being the result. As the scorching of which Sir Everard speaks could be only a slight blush, it might not be observed on a sable skin. However, I do not question the result of this experiment.

Sir Everard observed in his next experiment, during the course of an eclipse, as the darkness on the sun's disk diminished, the scorching power of the rays, concentrated by a lens, increased in a ratio which is assumed to be greater than could be accounted for by the mere rise of temperature during the time of the experiment. Whence it is to be inferred that the excess of effect is due to the increased quantity of light present with the heating rays at each advance of time. A reference to the original paper will convince the reader that this assumption is established without sufficient data.

Most stress has been laid by Sir Everard, and those who have adopted his views, on the seventh experiment. We are told that, on the 9th of September, at 11 A. M., thermometer 90° in the sun, the concentrated rays applied to a piece of black kerseymere wrapped round the arm, gave no real pain, as it is expressed, during 15 minutes; and at the end of that time left no appearance on the arm; whereas, when white kerseymere was substituted, during the same time, and the concentration we are led to suppose being the same, the heat of a thermometer in the sun only 86°, yet blisters were formed From this experiment, taken along with those preceding, it is supposed to be fully proved that although

black surfaces rise to a higher temperature than white under the sun's rays, yet they scorch the surface of the body less; the scorching effect depending on a union of the rays of heat with those of light, the latter being supposed, by way of explanation, to be excluded by the black surface. First, I shall state my repetition of the experiment, and then attend to Sir Everard's explanation of his supposed fact.

I have attempted to ascertain the rise which the absorption of heat by black and white cloths respectively gives to the thermometer; to compare this observation with the effects of the same cloths under the sun's rays upon the body, and with the effect of the sun's rays on the naked skin. When the thermometer stands at about 80° in the sun, the solar rays concentrated on white cloth over the ball of a thermometer, to a space of an inch and a half in diameter by a burning-glass, caused a rise of the thermometer to 125° in a quarter of an hour. When black cloth was substituted the rise during the same period was to 172°. In five minutes, with the white, the rise was to 108°, with the black to 140°; and in some experiments in a proportion nearer that given by the longer period.

When the black and white cloths were applied to the skin at the same temperature, and with the same degree of concentration, as already mentioned, the black cloth generally caused intense pain in the course of a few minutes, and on being allowed to remain for five or at most seven minutes, produced blisters. During the same period very little apparent effect followed the application of the white cloth, though considerable pain was sometimes produced. The experiment was at different times performed on several individuals, all of whom found the black cloth give the sensation of pain sooner than the white. On the whole, I found nothing like the difference described by Sir Everard, though certainly the vesicating effect of the black surface appeared to be much greater than that of the white. From many experiments I conclude, that the rays of the sun will scorch when they are applied to the surface so as to cause a heat of about 130° and upwards. And from the experiment related by Sir Everard, it appears that hot water is capable of producing a similar effect at that temperature. From all this, I am inclined to deny the existence of a scorching power in the sun's rays, independent of the heat they contain, or at least of the effect they produce on the thermometer. Moreover, if such a power do exist, black cloth should yet scorch more than white, since it will absorb all the rays of light, whereas the other surface will reflect them.

In those experiments which I performed, care was taken to have the white and black cloth nearly of the same density. Sir Everard does not

appear satisfied with his explanation of the extraordinary *fact* he relates, for he gives another furnished by Davy, who, indeed, is made to ascribe the alleged difference in vesicating power between black and white surfaces, to the former rendering the heat *sensible*. Were I not quoting from the Philosophical Transactions, a misprint might be suspected. I conclude that a black skin will absorb more heat than a white skin, and were it not for other accompanying circumstances, would produce inconvenience precisely in the ratio of the amount of heat absorbed. It must not be overlooked, however, that in the Negro the pigment is not superficial, but covered by a layer of translucent cuticle. The experiments of Dr. Stark prove that colours absorb heat in proportion to their depth of shade through transparent media. It only remains to show the cuticle to be a medium in the condition of those. For this purpose, I covered the balls of a differential thermometer, one with cuticle, the other with cuticle of the same thickness, having ivory black rubbed on its inner surface; on bringing the thermometer into the sun's rays, the column of liquid descended rapidly in the stem, the ball of which was covered with the blackened cuticle.

It is evident, from the result of experiments which I have related, that a much less degree of heat can be borne when the heat is applied locally, or so that the perspiratory process is not excited over the whole system, than Sir Joseph Banks and others were able to bear in heated apartments where perspiration was fully excited.

This circumstance leads me to offer an explanation of the functions, or, not to speak mincingly, of the *uses* served by the peculiar colouring matter in the dark races. Blumenbach and Dr. Winterbottom concur in stating the Negro to perspire more readily than the European or White, and Dr John Davy, in the 3d vol. of the Medico-Chirurgical Transactions, gives its due influence to this property. After noticing that the excessive perspiration in dark people must keep down the temperature, he proceeds, "In the inhabitants of the tropics, the exhalant arteries of the skin seem unusually expanded, and the whole apparatus peculiar to this secretion unusually developed; and I believe that the blood itself is less viscid, more fluid, and flows more readily through the vessels, so as to promote perspiration, and by that means contributing to the cooling of the surface, and being cooled itself, it contributes again when it flows back upon the heart, to the reduction of the temperature of the internal parts."

Were the inhabitant of the tropic not possessed of this organization, his system could not respond to the stimulus of heat, by a determination of fluid to the surface of the body. And the heat absorbed by the

skin being prevented from entering the system by the perspiratory process, the greater radiating power of a dark skin must be beneficial in cooling.

Again, the dark skin places the Negro in the conditions of his climate by causing him to radiate heat at night, and become at that time cooler than a White in the same circumstances. This is a fact which has been observed of the Negroes. Their propensity for exercise in the open air at night has been remarked. Thus we read that when the fleet of Hanno approached the shores of Negroland, the country which, during the day, presented only silent woods without the least trace of man, at night was lighted up with immense fires, while the woods resounded with the sounds of festivity. In a climate where, during the day, vegetation appears burnt up, the earth is cracked by the heat, and all living creatures languish; but where at night breezes refresh the air, and cheer exhausted nature, plants run with dew, and animals leave their haunts, man also, fitted by the structure of his skin to throw off heat, issues forth animated by the irresistible propensity to exercise which is always given by the bracing air of colder climates.—*Edinburgh New Philosophical Journal, October* 1840.—*January* 1841.

XII.—*Proceedings of the Madras Literary Society and Auxiliary of the Royal Asiatic Society.*

Thursday Evening, 6th August 1840.—A. D. CAMPBELL, ESQ. *President of the Committee of Papers, in the Chair.*

The following works, presented to the Society, were laid on the table, and thanks voted to the donors:—

Transactions of the Geological Society of London, Second Series, parts 1st and 2d of vol. 5th.—By the Society.

Journal of the Asiatic Society of Bengal for December 1839 and January 1840.—By the Society.

The Calcutta Journal of Natural History, No. 2.—By the Editor.

Dr. Corbyn's India Review, No. 50.—By the Editor.

Journal Asiatique for January 1840.—By the Society.

Asiatic Journal for March and April 1840.--By the Editor.

The following communications to the Society were laid before the Meeting:—

A notice, accompanied with a diagram, of the rocks passed over during a march from Secunderabad to Ahmednuggur in the Dekkan.—By Assist. Surgeon Balfour, 4th Battalion Madras Artillery.

An attempt to enumerate and form a Diagram of the Rocks near the Cantonment of Secunderabad—drawn up in 1838—By the same.

Some particulars respecting the statue of Sir Thomas Munro—By C.

On the basaltic granite of the Barramahal and the Basalt dykes of India, with a sketch—By Captain Campbell, Assistant Surveyor General.

Note on the Chenchu Wandlu or wild people of the Nulla Mulla hills. —By Lieutenant Newbold.

Note on the defaced state in which the statues of the Jains are now generally found, as connected with their persecutions and overthrow.—By the same.

Note on an ancient Hindu Grant—By Walter Elliot, Esq.

The following letter from the Right Honourable the Earl of Munster was read.

Sir,—I beg to apologize for addressing you, but, my object in so doing being of an interesting literary nature, I trust that you will not only forgive my thus intruding on your valuable time, but that you will (as *much depends* on your *co-operation*), kindly, and warmly, enter into my views.

I have been for many years employed in collecting materials for a Military History of the Mahomedan nations, from the rise of their founder till the present time, and have already made great progress in all details relative to the different people, who have embraced that religion, whether of Arabian or Tartar origin.

I have lately drawn up, in Arabic, a list of military and historical books, which I am desirous to procure, and have accompanied it with a military notice, of some length, in order to point out the subject of the works, which would be most adapted to my researches.

Perhaps you may be so situated, as to assist me in its dissemination, and although I am fully aware of the difficulty that surrounds an at-

tempt of this nature in some Mahomedan cities, yet I hope you may have formed an acquaintance with some Sheick or learned man, who might be persuaded to aid in searching for, and purchasing for me, the books I require.

Should such a person exist, I shall be grateful if you will, with whatever precaution or secresy that may be deemed necessary, put the accompanying Memoir into his hand, and invite him to meet my wishes, by procuring for me the class of historical and military works, named or indicated in it, not only in Arabic, but in Turkish, Chagataï or Tartar, in Persian, Hindostanee, and in all the indigenous languages of India.

But, not only do I look for books, but I should be greatly pleased and aided, by any learned and intelligent Mahomedan gentleman or officer (some of the latter of Western Asia having been of late years educated in Europe) referring to my military memoir, and answering my questions, one by one, and if he would give me in writing the information I desire, including all military technical synonimous terms, of the present as well as of past times.

It is possible, in Egypt, Western Asia and Persia, and still more likely in India, that some European gentlemen from long residence in those countries, may be equal to answering the various *items* of my Memoir. I have reason to believe, that there are several intelligent European Officers in the armies of the Osmanli, of Mahomet Aly Pascha and of Persia—thus situated—while in India, many Civilians and Officers of the India Company's Service, I know to be highly qualified to give me the aid I solicit, and who might, from advantages of vicinity and other circumstances, enter fully upon the Mahomedan art of war in India, of all past centuries, to the present time.

If any gentleman in India, would thus enter into my views, I would particularly point out (besides the past art of war of Persian and Tartar origin and the collection of the past and existing military terms and expressions, of the present native camps and armies) the ancient indigenous Hindoo mode of warfare, previous to, and wholly unconnected with, that introduced by their northern conqueror, and to the military terms (not forgetting the modern) either in the Sanscrit, or as preserved in its cognate existing languages.

I need hardly say, that I shall not be backward in acknowledging, both privately and publicly any such assistance.

I have limited the notices in my Memoir, to the end of the temporal power of the Eastern Khalifs (334 H.) ; considering the details I have

brought forward, sufficient to be a guide for similar researches in after periods and dynasties, and which I wish to be equally illustrated, whether of the Ommiades of Spain, of the Fatimites of Egypt, of the minor kingdoms of the West of Asia on the decline of the court of Bagdad, of the Siljuks, of the Moguls of Ghinges Khan, of Persia, and, of farther East—of the Ghisnivides, Goarides of the Pitan Kanes, and of the family of Timour, at Delhi, and of the numerous sovereignties both of Hindostan and of the Dekkun.

I have reason to believe that the price of books (whatever it may be in Persia, India, or Cabul) in Western Asia, is far from exorbitant, having just received two volumes from Egypt of considerable intrinsic value, for which I only paid 123 Piastres or 23 shillings, and would not wish you (as I am making similar purchases throughout the Mahomedan world) to give, on ordinary occasions, above one pound or 30 to 100 Piastres, for a single volume.

But as some peculiarly scarce, interesting and valuable works, may be offered, I shall beg of you to use your own discretion, as to their prices and immediate purchase, or in first letting me know, what is asked for them or in that of the alternative of having them, if possible, copied.

You may rest assured, I shall be perfectly satisfied with your decision, and shall be grateful, (should you be inclined to meet my wishes) if you will, as soon as you have ascertained that the books selected are pertinent to my objects, to pay for them, and I will instantly on receiving your letter, transfer the amount to your Bankers in London, including any expence on their transmission to 13 Belgrave Street, London—the mode of which, I must leave to your friendly arrangement.

I have the honour to be,

Sir,

Your obedient Servant.

(Signed) Munster.

Lord Munster's communication is referred to the Committee of Papers, who are requested to further by all means in their power the wishes of his Lordship.

Read the following letter from the same Nobleman, accompanying his *Index* of books desired.

Sir,—I trust the Literary Society of Madras will kindly accept the accompanying Memoir, rather as a literary curiosity than for any actual merit it possesses, but I trust the subject and object—for which I

have drawn it up, will attract the notice of some of the Society's Members and cause them to aid my views and wishes.

Trusting I shall hear from you to that effect,

I have the honour to be,

Sir,

Your obedient Servant.

(Signed) MUNSTER.

PARIS, 3d May 1840.

Resolved, that every assistance in the Society's power be afforded to his Lordship.

Read a letter from Lieutenant J. Whitlock, 8th Cavalry, forwarding a spherical sandstone concretion, from the red marle cliffs of Dawlish in Devonshire, which he supposes to be of the same character as those described in the proceedings of the Society's Meeting of the 13th of February last, as having been found in the laterite formation at Streepermadoor:— offering, also, to procure for the Society specimens of the Alcyonites found at Gurrah, near Nagpore.

The thanks of the Society were voted to Lieutenant Whitlock for his donation, and an assurance that the promised fossils will be thankfully received.

Read extract from a letter from Lieutenant T. J. Newbold, dated Suez, 31st May 1840, forwarding for the Society's Museum minerals from the shores of the Red Sea.

The thanks of the Society were voted for the same.

Read a letter from the Secretary to the Geological Society expressing thanks for the donation of the Society's Journal No. 23.

Thursday Evening, 3d *September* 1840—*Captain* J. T. SMITH, *in the Chair.*

The following works, presented to the Society, were laid on the table, and thanks voted for the same:—

Transactions of the Agricultural and Horticultural Society of India—vol. 7th—By the Society.

Journal of the Asiatic Society of Bengal, Nos. 13 and 14—By the Society.

Corbyn's India Review and Journal of Foreign Science and the Arts, No. 53, August 1840—By the Editor.

Topography of Calcutta—By Dr. Strong, presented, on the part of the author, by D. Ross, Esq.

The following communications to the Society, were laid before the Meeting:—

Continuation of the Catalogue of the birds of Southern India, by T. C. Jerdon, Esq.—Tribe Conirostres.

Mr. Elliot's notice of some Roman coins found near Sholapoor.

Horary Meteorological Observations made agreeably with the suggestions of Sir John Herschel.

1*st.—At the Madras Observatory on the* 21*st June* 1840.

1840.	Time.	Barometer.	Thermometer. Dry.	Thermometer. Wet.	Direction of wind.	Strength of wind.	Remarks.
June 21	6 A. M.	29,816	86,5	12,0	s w	2	Thick haze—strong wind.
	7	840	86,9	11,9	w	2,3	Haze do. do.
	8	850	87,9	12,5	w	3	Do. do. do.
	9	862	90,0	14,0	w	3	Do. do. do.
	10	860	91,0	14,8	w	3,4	Do. do. do.
	11	843	92,9	16,3	s w	4	Fl. clouds do. do.
	12	824	95,7	18,7	w	3	Do. do. do.
	1 P.M.	818	97,7	20,2	w	3	Do. do. do.
	2	792	98,7	21,0	w	3	Do. do. do.
	3	770	99,7	22,1	w	4	Do. do. do.
	4	756	99,8	22,4	w by n	3	Cloudy.
	5	758	98,2	21,4	sw by w	2,3	Do.
	6	764	98,0	21,5	s s w	2	Do.
	7	790	96,4	19,4	s w	1	Do. gentle wind—lightn.
	8	800	89,8	7,9	s w	1	Do. do. do. do.
	9	810	93,8	17,3	s w	2,3	Do. strong wind—thr. & lt.
	10	848	94,3	18,8	w	2,3	Do. do. lightning
	11	846	93,0	17,6	w	2,3	Do. do. do.
	12	832	92,0	16,0	w	2,3	Thick haze, strong wind, ltn.
	1 A.M.	804	89,0	14,0	w	3	Do. do. do. do.
	2	786	87,5	12,4	w	3,4	Do. do. do. do.
	3	778	87,0	12,1	s w	3	Do. do. do. do.
	4	772	86,2	11,2	sw by w	3	Do. do. do. do.
	5	790	85,9	10,9	sw by w	3	Do. do. do. do.
22	6	800	85,4	10,5	sw by w	3	Do. do. do. do.
	7	806	86,4	11,2	sw by w	2,3	Do. do. do. do.
	8	810	88,4	13,2	sw by w	3,4	Haze—strong wind.
	9	816	90,3	14,3	w	4	Haze—very strong wind.
	10	820	92,3	15,4	w	4	Fl. cl.—very strong wind.
	11	808	92,8	16,3	w	4,5	Fl. cl. do. do. do.
	12	774	95,7	18,3	w	4	Fl. cl. do. do. do.
	1 P.M.	750	97,7	20,2	w	4	Fl. cl. do. do. do.
	2	726	98,9	21,9	w	4	Thick hz.—very strong wind.
	3	734	100,5	23,5	w	3	Cloudy—strong wind.
	4	682	100,3	23,5	w n w	2,3	Cloudy.
	5	678	100,0	23,3	w by s	3	Cloudy.
	6	702	98,2	21,9	w s w	2	Cloudy.

2d.—*At the Trevandrum Observatory at the Autumnal Equinox* 1840.

Date.	Hour.	Newman's Standard bar. corrected for temp. 32° and for capillarity.	Standard thermometer.	Depress. of wet bulb. thermometer.	Dew point.	Direction of wind.	Velocity of the wind.	Solar radiation.	Clouds, aspect of the sky and remarks.
Sept. 21	6 A.M.	29.671	73.8	2.4	70.27	N. W by W.	3		Sky rather clear cold wind.
	7	.697	75.2	2.6	71.43	do.	3	2.5	Do. do.
	8	.714	77.0	3.6	71.82	do.	5	3.0	Do. gentle wind.
	9	.715	79.5	4.9	72.52	do.	5	5.5	Flying clouds. do.
	10	.715	81.5	6.4	72.40	do.	5	4.5	Do. do.
	11	.687	84.0	7.9	72.85	do.	5	Cly.	Do. do.
	Noon.	.664	85.0	7.9	73.97	do.	5	7.0	Do. do.
	1 P.M.	.641	85.6	9.0	72.95	W.	3	2.5	Do. cumuli about hor. do. increasing.
	2	.615	85.0	9.2	71.94	do.	6	8.0	Do. do. pleasant wind.
	3	.609	84.7	9.1	71.75	do.	3	3.0	Do. do. gentle wind.
	4	.606	83.9	8.1	72.43	do.	4	3.3	Do. do. do.
	5	.628	81.8	6.0	73.34	do.	4		Sky cloudy do.
	6	.643	79.9	5.4	72·19	do.	2		Sky getting clear light air.
	7	.668	78.8	4.3	72.68	W. by N.	2		Sky pretty clear do.
	8	.697	78.2	4.4	71.88	do.	1		Do. do.
	9	.715	77.7	4.2	71.65	do.	1		Do. do.
	10	.726	77.2	3.7	71.88	do.	,,		Sky getting cloudy calm.
	11	.709	76.4	3.1	71.94	do.	,,		Cloudy do.
	Mid.	.707	76.0	2.7	72.12	do.	,,	No observation.	Do. do.
,, 22	1 A.M.	.681	75.6	2.1	72.59	W.	2		Do. at 1h. 10m. rain—wind just perceptible.
	2	.652	75.4	1.6	73.12	do.	,,		Zenith clear nearly calm.
	3	.649	75.2	1.5	73.06	do.	,,		Sky rather cloudy. do.
	4	.647	75.0	1.7	72.56	do.	,,		Do. do.
	5	.651	74.3	1.7	71.84	do.	,,		Do. do.
	6	.672	74.5	1.6	72.19	N. W by W.	2		Do. light air.
	7	.687	75.9	1.5	73.78	W. N. W.	2	0.5	Do. do.
	8	.630	77.2	2.4	73.81	N. W by N.	5	1.8	Do. gentle wind.
	9	.701	79.2	3.1	74.87	W. by N.	4	4.3	Flying clouds do.
	10	.688	81.0	4.7	74.43	W.	3	Cly	Cloudy do.
	11	.665	82.2	5.5	74.53	do.	6	9.0	Thick cumuli rising; pleasant do.
	Noon.	.642	84.6	7.1	74.73	do.	3	8.8	Sky getting clear gentle do.
	1 P.M.	.609	85.5	8.1	74.21	do.	4	11.0	Do. do.
	2	.587	85.0	7.9	73.97	do.	4	9.5	Do. do.
	3	.570	85.5	8.4	73.76	do.	4	3.5	Cirrus in the zenith; cumuli about the hor. gentle wind.
	4	.567	85.0	9.6	71.29	do,	3	4.5	Clear do.
	5	.582	82.0	7.7	70.91	do.	3	2.5	Very clear do.
	6	29.606	79.8	5.1	72.54	do.	3		Do. do.

September 21st rain fell from 6 A. M. to 6 P. M. None.

do. 6 P. M. to 6 A. M. ·0421.

September 22d do. 6 A. M. to 6 P. M. None.

Total. ·0421

The Instruments are the same, and situated exactly as before.

G. Sperschneider, *Superintendent.*

METEOROLOGICAL REGISTER KEPT AT THE MADRAS OBSERVATORY; FOR THE MONTH OF APRIL, 1840.

Days.	Barometer at 10 A. M.	Barometer at 4 P. M.	Barometer at 10 P. M.	Ther. at 10 A. M.	Ther. at 4 P. M.	Ther. at 10 P. M.	Wet Bulb. 10 A. M.	Wet Bulb. 4 P. M.	Wet Bulb. 10 P. M.	Rain. Sun-rise.	Rain. Sun-set.	Evaporation.	Strength of wind.	Direction of Wind. 10 A. M.	Direction of Wind. 4 P. M.	Direction of Wind. 10 P. M.	Cloudy Max.	Weather. 10 P. M.	Weather. 4 P. M.	10 P. M.	Remarks.
1840	Inch.	Inch.	Inch.	o	o	o	o	o	o												
Apr. 1	30,114	30,003	30,082	83,5	85,6	83,0	5,3	8,2	5,0	......	......	2,478	2,3	E	S E	S E	1	Clear.	Clear	Clear	dew.
2	,150	,010	,082	83,7	86,0	82,8	6,2	7,0	4,3	......	......	......	2,3	S E	S. S E	S	1	Fl. cl.	Clear	Clear	do.
3	,102	29,945	,022	84,0	87,0	83,6	5,7	8,0	5,2	......	......	......	2,3	S	S E	S	1	Clear	Clear	Clear	do.
4	.038	,948	,016	84,5	86,0	83,1	6,4	6,2	3,2	......	......	......	2,3	S	S E	S E	3	Clear	Clear	Fl. cl.—lightning.	do.
5	29,998	——	29,992	86,0	—	84,0	6,5	—	2,5	......	......	......	2,3	S W	——	S E	3	Clear	——	Haze do.	——
6	30,022	29,916	30,000	86,0	87,0	84,0	6,5	7,0	4,0	......	......	......	2,3	S	S by E	S	2	Fl. cl.	Clear	Clear do.	——
7	,034	,900	29,982	85,6	87,4	84,2	5,6	6,7	3,2	......	......	......	2,3	S W	S E	S E	3	Fl. cl.	Clear	Fl. cl. do.	——
8	,002	,897	,972	85,6	87,6	84,0	7,2	7,8	4,5	......	......	2,833	3	S W	S E	S E	2	Fl. cl.	Clear	Clear do.	——
9	,014	,903	,968	86,0	86,2	83,9	6,6	6,2	4,0	......	......	......	3	S	S. S E	S E	2	Clear	Clear	Clear do.	——
10	,020	,900	,974	85,7	87,0	84,0	6,2	8,4	4,0	......	......	......	2,3	S	S	S	2	Fl. cl.	Clear	Clear do.	——
11	,000	,882	,956	85,5	87,0	83,8	7,7	7,0	3,3	......	......	......	2,3	S	S. S E	S E	1	Fl. cl.	Clear	Clear do.	——
12	,000	——	,992	86,0	—	85,5	2,5	—	4,1	......	......	......	2,3	S	——	S E	1	Fl. cl.	——	Clear ——	——
13	,016	,907	30,000	86,5	88,3	84,5	7,0	—	3,5	......	......	......	2,3	S	S E	S	1	Fl. cl.	Clear	Clear ——	——
14	,012	,888	29,978	86,8	88,0	85,0	8,4	6,7	4,0	......	......	......	2,3	S W	S E	S	1	Clear	Clear	Clear—lightning	——
15	29,962	,858	,920	86,8	87,0	84,4	7,3	5,5	2,9	......	......	......	2,3	S W	S E	S	1	Clear	Clear	Clear ——	
16	,962	,838	,922	87,5	89,0	85,2	8,0	8,3	3,3	......	......	......	2,3	S W	S E	S	2	Clear	Clear	Fl. cl. ——	
17	,966	,870	,958	86,6	87,0	83,9	4,6	5,5	3,6	......	.....	......	2,3	S. S E	S E	——	2	Clear	Clear	Haze ——	
18	30,018	——	30,044	85.3	—	85,9	5,9	—	4,6	......	......	......	2,3	S	——	——	2	Clear	——	Clear ——	
19	——	——	,000	—	—	85,9	—	—	4,2	......	......	......	2,3	——	——	S E	1	——	——	Clear ——	
20	——	——	29,926	—	—	84,3	—	—	3,4	......	......	......	2,3	——	——	S	1	——	——	Clear ——	
21	29,943	29,783	,842	86,5	86,4	84.0	8,1	5,0	3,5	......	......	3,011	3	S W	S E	S E	2	Clear	Clear	Haze—lightning.	
22	,842	,770	,864	88,5	86,3	85,9	9,0	5,5	4,5	......	......		2,3	S W	S E	S E	2,3	Haze	Haze	Haze do.	
23	,914	,800	,862	87,7	88,0	84,2	7,7	7,3	3,8	......	......		2,3	S E	S E	S E	2	Fl. cl.	Clear	Clear do.	
24	.898	,755	,848	87,8	88,2	85,7	8.4	6,7	3,7	......	......		2,3	S W	S E	S E	2	Fl. cl.	Th. hz.	Haze ——	
25	,838	.710	,790	89,8	88,0	85,9	0,9	6,3	2,1	......	......		2,3	S W	S E	S W	2	Clear	Clear	Haze—lightning	
26	,770	——	,766	89,8	—	87,3	10,8	—	4,8	......	......		2,3	S W	——	S	2,3	Haze	——	Fl. cl. land-wind th. and lightn.	
27	,734	,614	,706	91,8	91,0	89,7	2,3	6,5	6,7	......	......		2,3	W	S E	S. S W	4	Clear	Haze	Haze th. and vivid lightning.	
28	,728	,628	,720	93,0	90,0	88,4	5,3	—	6,4	0,025	......		2,3	N. N W	S E	Calm	3	Clear	Clear	Thick haze ; lightning.	
29	,698	,605	,684	90,7	91,3	89,2	8,9	9,8	4,7	......	......	3,280	2,3	N. N W	S E	S	4	Haze	Haze	Haze lightning.	
30	,696	,568	,680	90,1	99,0	89,8	9,3	9,4	5,4	......	......		2,3	W	S E	S	3	Haze	Th. hz.	Haze—vivid lightning.	
Mean	29,946	29,829	29,918	87,0	88,1	85,2	6,6	7,0	4,1												

METEOROLOGICAL REGISTER KEPT AT THE MADRAS OBSERVATORY ; FOR THE MONTH OF MAY, 1840.

Days.	Barometer at 10 A. M.	Barometer at 4 P. M.	Barometer at 10 P. M.	Ther. at 10 A. M.	Ther. at 4 P. M.	Ther. at 10 P. M.	Wet Bulb. 10 A. M.	Wet Bulb. 4 P. M.	Wet Bulb. 10 P. M.	Rain. Sun-rise.	Rain. Sun-set.	Evaporation.	Strength of wind.	Direction of Wind. 10 A. M.	Direction of Wind. 4 P. M.	Direction of Wind. 4 P. M.	Cloudy Max.	Weather. 10 A. M.	Weather. 4 P. M.	Remarks. 10 P. M.
1840	Inch.	Inch.	Inch.	o	o	o	o	o	o											
May 1	29,744	29,643	29,798	91,8	93,0	86,5	8,3	11,7	6,1	......	......	......	2,3	W	S	S. SE	2	Haze	Haze	Haze—lightning.
2	,856	,750	,858	89,8	89,0	87,8	11,8	6,8	6,4	......	......	......	2,3	W	S	S	3	Clear	Cloudy	Fl. cl. do.
3	,888	——	,822	88,6	—	90,3	9,2	—	7,3	......	......	......	2,3	S W	——	S	3	Clear	Cloudy	Fl. cl. do. and thunder.
4	,854	,714	,800	91,5	94,0	88,2	12,5	13,6	6,2	......	......	......	2,3	S W	S E	S. S W	3	Clear	Cloudy	Fl. cl. do. do.
5	,864	,743	,812	92,0	93,0	88,2	12,4	13,3	6,7	......	......	......	2,3	S W	S E	S. S W	3	Clear	Cloudy	Clear do. do.
6	,890	,800	,876	90,9	90,7	86,4	11,5	8,2	3,8	......	......	3,492	2,3	swbyw	S W	S	3	Clear	Cloudy	Th. hz. thunder in the evening.
7	,900	,790	,860	91,0	92,0	89,2	12,1	10,0	6,7	......	......	......	2,3	S W	S W	S W	3	Cloudy	Cloudy	Clear, thunder, lightning and drizzling rain at 5 P. M.
8	,872	,770	,834	92,5	93,0	91,0	16,0	10,3	8,0	......	......	......	2,3	W	S W	S	3	Clear	Cloudy	Fl. cl. thunder at 4 P. M.
9	,866	,766	,834	89,7	89,7	89,4	9,2	12,4	19,3	......	......	......	2,3	W	N W	W	4	Fl. cl.	Cloudy	Th. hz. do. lightning and drizzling rain at 4. P. M.
10	,876	——	,866	89,5	—	89,0	9,2	—	5,4	......	......	......	2,3	W	——	S	3	Clear	——	Th. hz. lightning.
11	,896	,782	,890	89,3	89,6	86,6	11,8	8,9	3,2	......	......	......	2	swbyw	S W	S W	2	Haze	Th. hz.	Clear do.
12	,916	,810	,902	88,4	89,8	88,6	9,2	7,8	4,9	......	......	......	2,3	S W	S W	S	2	Haze	Th. hz.	Haze do. th. hz. at night.
13	,938	,808	,916	88,6	89,0	86,7	10,0	7,6	4,2	......	......	3,808	2,3	S W	S W	S	2	Clear	Th. hz.	Clear do. th. hz. at night.
14	,916	,810	,908	90,3	90,0	87,4	11,4	9,3	5,4	......	......	......	2,3	S	S	S	2	Clear	Haze	Haze ——
15	,927	,796	,862	91,0	92,0	86,3	13,5	12,0	5,9	......	......	......	3	S W	S	S. S W	0	Clear	Haze	Clear ——
16	,892	,766	,830	92,4	91,6	86,6	13,4	11,8	6,6	......	......	......	2,3	swbyw	S. S W	S. S E	2	Clear	Clear	Clear lt. strong wind at night.
17	,814	——	,854	93,0	—	91,0	12,0	—	12,4	......	......	......	2,3	W N W	——	S	3	Clear	——	Fl. cl. loud th. and vivid lightn.
18	,928	,796	,876	82,8	89,7	85,9	5,3	8,2	5,9	......	......	......	2,3	Nwbyw	S W	S	3	Cloudy	Clear	Haze lightning.
19	,888	,778	,836	88,2	91,3	87,2	8,2	10,3	5,2	......	......	......	3	W	S W	S W	2	Clear	Clear	Clear do. strong wind at night.
20	,842	,735	,810	90,6	91,8	87,0	11,7	11,0	7,0	......	......	3,093	3	S W	S W	S	2	Clear	Clear	Clear do. do. do.
21	,828	,730	,830	90,9	90,8	89,2	13,9	10,0	6,1	......	......	......	4	S W	S W	S	4	Clear	Cloudy	Cloudy do. do. do. and drizzling rain in the morning.
22	,862	,743	,831	91,2	92,0	89,5	11,2	10,0	7,8	......	......	......	3	S W	S W	S W	3	Haze	Cloudy	Th. hz. thunder and lightning.
23	,848	,737	,818	91,8	92,7	87,7	15,9	11,7	7,7	......	......	......	3	S W	S W	S. S W	4	Clear	Clear	Clear lightning.
24	,850	,738	,852	91,0	90,0	89,0	11,5	7,5	7,0	......	......	......	3	S W	S W	S W	2	Clear	Clear	Clear do.
25	,898	,764	,856	90,8	92,0	88,3	12,8	8,0	6,8	......	......	......	2	W	S W	S E	2	Clear	Clear	Clear do.
26	,886	,774	,838	90,3	91,8	90,5	10,8	10,3	9,0	......	......	......	2	W	S W	S W	2	Clear	Clear	Cloudy do.
27	,862	,770	,840	91,7	93,3	90,3	13,7	10,0	9,9	......	......	4,255	3	S. S W	S W	S. S W	3	Clear	Cloudy	Cloudy do.
28	,822	,728	,836	91,7	90,0	89,8	13,9	11,2	6,4	......	......	......	3	S W	S W	S	4	Haze	Cloudy	Cloudy vivid do.
29	,832	,730	,808	90,0	90,3	87,8	7,0	6,0	5,8	......	......	......	2,3	S. S E	S E	S	1	Clear	Clear	Clear lightning. [and night.
30	,846	,720	,814	89,9	90,0	85,9	11,9	7,2	2,9	......	......	......	2,3	S W	S E	S	1	Clear	Clear	Clear do. strong wind at day
31	,828	——	,818	89,3	—	88,0	6,3	—	5,0	......	......	......		S. S E	——	S	3			—— do.
Mean.	29,869	29,759	29,815	90,3	91,2	88,2	11,2	9,9	6,8											

METEOROLOGICAL REGISTER KEPT AT THE MADRAS OBSERVATORY; FOR THE MONTH OF JUNE, 1840.

Days.	Barometer at 10 A. M.	Barometer at 4 P. M.	Barometer at 10 P. M.	Ther. at 10 A. M.	Ther. at 4 P. M.	Ther. at 10 P. M.	Wet Bulb. 10 A. M.	Wet Bulb. 4 P. M.	Wet Bulb. 10 P. M.	Rain. Sun-rise,	Rain. Sun-set.	Evaporation.	Strength of wind.	Direction of Wind. 10 A. M.	Direction of Wind. 4 P. M.	Direction of Wind. 10 P. M.	Cloudy Max.	Weather. 10 A. M.	Weather. 4 P. M.	Remarks. 10 P. M.
1840	Inch.	Inch.	Inch.	o	o	o	o	o	o											
June 1	29,798	29,712	29,786	89,8	89,2	86,7	12,8	7,7	6.7	......	......	......	2,3	S	S E	S W	4	Haze	Cloudy	Fl. cl. lightning.
2	,812	,710	,790	88,5	90,3	86,2	8,0	6,3	2,7	......	......	......	,2	S	S E	S E	2	Fl. cl.	Haze	Clear do.
3	,842	,742	,850	88,7	88,3	87,9	5,7	7,3	4,2	......	......	3,346	,2	S.SE	S E	S E	2	Fl. cl.	Th. hz.	Th. haze do.
4	,864	,760	,850	88,7	90,0	86,8	7,7	8,0	4,4	......	......	......	,2	E	S E	S E	1	Clear	Clear	Cloudy do.
5	,824	,722	,814	88,2	89,0	86,3	6,2	8,0	4,3	......	......	......	,2	S.SE	S E	S E	1	Haze	Clear	Clear—vivid do.
6	,800	,713	,826	87,9	88,3	86,3	5,8	6,9	4,8	......	......	......	,2	E	S E	S E	2	Fl. cl.	Clear	Fl. cl. do.
7	,808	——	,822	88,5	——	87,5	6,5	—	4,1	......	......	......	,2		——	S E	4	Clear	——	Fl. cl. thunder and lightning.
8	,818	,720	,802	87,8	90,0	87,0	7,3	9,3	4,5	0,077	......	......	,2	S W	S E	S E	2	Fl. cl.	Clear	Fl. cl. do.
9	,778	,673	,748	90,9	91,2	89,7	4,9	8,2	8,7	......	......	......	,2	W	S E	S	4	Haze	Cloudy	Haze and flying cl. vivid do.
10	,752	,650	,766	90,0	84,0	89,2	11,5	3,3	9,8	......	......	2,985	,2	W	S E	S	3	Haze	Cloudy	Fl. cl. thunder in the evening lightning at night.
11	,862	,640	,750	90,8	90,0	88,7	12,3	6,8	4,1	......	......	......	,2	N W	E by S	S	2,3	Haze	Cloudy	Cloudy lightning.
12	,752	,658	,750	84.3	89,0	83,5	5,9	—	4,5	......	......	......	,2	S W	S SW	S W	8	Cloudy	Cloudy	Cloudy do.
13	,732	,668	,704	83,9	84,0	84,2	5,9	5,2	5.7	0,155	......	......	,2	W	N W	W	9	Cloudy	Cloudy	Cloudy do.
14	,726	——	,700	86,0	——	85,9	8,3	—	8,4	......	......	......	,2	W	——	S W	9	Cloudy	——	Cloudy do.
15	,722	,630	,764	88,2	93,2	87,2	12,3	16,2	7,8	......	......	......	,3	W	S W	S W	8	Th. hz.	Cloudy	Cloudy do.
16	,766	,700	,800	90,2	92,8	89,8	3,3	15,8	5,8	......	......	......	,3	S W	S E	S	7	Haze	Cloudy	Haze do.
17	,826	,730	,816	90,8	93,3	90,6	12,9	14,3	7,7	......	......	3,013	2,3	S W	SE by S	S	7	Haze	Cloudy	Haze do.
18	,820	,700	,780	89,0	95,3	91,9	13,1	18,3	9,5	......	......	......	2,3	W	W.SW	S	6	Haze	Cloudy	Fl. cl. do.
19	,798	,683	,756	91,0	94,5	91,9	14,1	17,7	9,1	......	......	......	2,3	SWbyW	S W	S	5	Haze	Cloudy	Haze do.
20	,826	,714	,804	91,6	97,8	92,0	14,6	20,3	9,0	......	......	......	,3	SWbyW	W by N	S	7	Haze	Cloudy	Fl. cl. do.
21	,860	,756	,848	91,0	99,8	94,3	14,8	22,4	18,8	......	......	......	,3	W	do.	W	7	Haze	Cloudy	Cloudy thunder and do. strong wind at day and night.
22	,820	,682	,770	92,3	100,3	94,4	15,4	23.5	16,2	......	......	......	,3	W	W.NW	S W	5	Fl. cl.	Cloudy	Haze do. do. do. do.
23	,776	,660	,768	91,8	100.0	95,5	15,8	23,0	18,5	......	......	......	,3	W	W by S	W	5	Haze	Cloudy	Fl. cl. do. do. do. do.
24	,802	,710	,834	92,9	96,8	92,5	16,9	18,8	10,9	......	0,032	5,339	2,3	W	E	S W	6	Clear	Cloudy	Cloudy do.
25	,852	,758	,852	91,7	93,0	90,0	15,6	13,0	7,0	......	......	......	2,3	SWbyW	E. SE	S	6	Haze	Fl. cl.	Cloudy do.
26	,888	,780	,854	91,7	92,3	86,6	15,8	9,0	2,1	......	0,217	......	2,3	W.NW	E. SE	S	5	Haze	Cloudy	Fl. cl. do.
27	,868	,764	,854	90,8	92,0	89,5	12,2	11,5	7,1	......	......	......	2,3	N W	E. SE	S	5	Clear	Fl. cl.	Fl. cl.—rainbow to the west thunder and lightning.
28	,850	——	,842	89,0	——	89,7	11,1	—	7,3	......	......	......	2,3	W	——	S	6	Clear	Fl. cl.	Cloudy—lightning.
29	,840	,760	,840	91,0	85,8	87,9	12,7	7,8	8.0	......	......	......	2,3	S W	N	S E	5	Fl. cl.	Cloudy	Fl. cl. thunder in the afternoon
30	,858	,810	,854	89,8	89,0	85,9	11,3	9,5	8,4	......	......	......	,2	N W	W. NW	S W	4	Fl. cl.	Cloudy	Haze—lightning.
Mean	29,811	29,711	29,800	89,6	91,8	88.9	10.7	12,2	7,7											

The instruments with which the foregoing observations are made, are placed in the Western Verandah of the Honourable Company's Observatory; at about five feet above the surface of the ground, and twenty-seven feet above the level of the Sea: the thermometer was made on purpose for the Observatory, and at 75° (the only point at which a comparison has been made) it was found to differ insensibly from the Royal Society's Standard; the barometer is one of two Standards which have been lately constructed, and may be depended upon to 0,0100 an inch.

J. Crisp, Major.
H. C. Acting Astronomer.

MADRAS JOURNAL

OF

LITERATURE AND SCIENCE.

No. 29—October 1840.

I.—*Catalogue of the Birds of the Peninsula of India, arranged according to the modern system of Classification; with brief Notes on their Habits and Geographical Distribution, and description of new, doubtful and imperfectly described Species.—By* T. C. Jerdon, *Assistant Surgeon, 2d Madras Light Cavalry.*

(*Concluded from No.* 28 *page* 15.)

Ord. GRALLATORES.—*Waders.*

Family ARDEADÆ.—*Cranes* and *Herons.*

Genus GRUS, L.—*Crane.*

I shall commence this family with the *Cranes*, which have been accidentally omitted in Swainson's Synopsis.

297.—*G. Antigone*, Edw. pl. 45.—*Sarrus*, H.—*Greater Indian Crane.*

I have only observed this fine bird once or twice on the banks of the Godavery and Kistnah rivers, but extract from Mr. Elliot's notes the following excellent observations, chiefly made in Guzrat, it being but a rare visitant to the Southern Mahratta Country.

" The *Sarrus* lives always in pairs, though several pairs are frequently seen together, and occasionally, though rarely, a stray bird, either a young one, or one that has lost its mate, with another pair. Every morning they are seen at sun-rise winging their way to the cultivated fields, to feed upon grain, their sole aliment—and about 11 or 12 o'clock, they make their way to the nearest water to drink, always preferring the sandy beds of rivers, where they are seen in the greatest numbers, but not disdaining to resort to tanks, should no stream be near. There they remain all day, and at evening again, betake themselves to the fields, returning to pass the night by the water side. When alarmed and when on the wing in the morning flights, they utter a fine clear trumpet-like note."

The *Sarrus* is migratory, appearing in the Peninsula only in the cold weather.

Irides vinous red; bill pale sea green, brownish at the tip; legs rosy red, passing into brown in front. Length 52 inches; expansion of wings 7 feet 9 inches; tarsus 13; bill 6; weight 17 lbs.

From the testimony of Shikaries and others, there appears to be another large *Crane*, which occasionally visits the Peninsula, and from the descriptions I have heard, it is probably the *Grus Torquata* of Vieillot and Wagler.

298.—*G. cinerea.*—*Ardea Grus*, L.—*Koolung*, H.—*Common Crane.*

The well known *Crane* is found in India in the cold season only, living in pairs or small parties of 6, 8, or more. Has similar habits and food with the *Sarrus Crane.* On one occasion I found the flowers of the Koosoom (*Carthamus tinctorius*) to have been the only food partaken of. This was late in March when most of the grains were cut. The *Koolung* is often seen in company with the next bird.

Irides reddish yellow, brown in some; bill sea green; legs black. Length 3½ feet; expansion of wings about 6 feet; tarsus 8½; bill at front 4.

Sub Genus ANTHROPOIDES, Vieillot.

299.—*A. Virgo.*—*Ardea Virgo*, L.—*La Demoiselle*, Buff. P. E., 241. —*Kurronch*, H. also *Kurkurrah.*—*Kurkoncha*, Can.; all named from the call of the bird—*Demoiselle Crane.*

This most elegant, and chastely coloured bird is found over most of the Peninsula, during the cold weather, and in much greater numbers

than either of the two last *Cranes.* Like these it is most abundant in the neighbourhood of the larger rivers, and has similar habits and food.

Mr. Elliot in his notes says " Flies in vast flocks—from 50 to 100, and even 500, with great regularity of arrangement, in a long line, a few of the leading ones disposing themselves in another line at an angle, varying from a right to an acute one with it. This is when they are in progress—at other times, as when disturbed during the heat of the day, they may be seen circling round at a great height, but still a regular order of lines may be distinguished. Their favourite food is chenna (*Cicer arietinum*). They never go to tanks to drink but always to rivers." When this bird is struck by a *Bhyree* (*Falco peregrinus*) its mate generally comes to its assistance. The *Bhyree* always strikes it on the back and wings, to avoid being wounded by the sharp inner claw, with which, if struck on the head, it generally manages to inflict severe wounds on the breast of the falcon.

Irides fine vinous red; bill greenish at the base, yellowish in the middle, and inclining to pink at the tip; legs black. Length $2\frac{1}{2}$ feet; expansion about 5 feet; tarsus $6\frac{1}{2}$ inches; bill to front $2\frac{3}{10}$ths.

The inner claw of all these *Cranes* is much hooked, and exceedingly sharp, and it always in self-defence strikes with its claw and never with its bill.

Genus ARDEA, *Heron.—Buglah*, H.

Sub Genus ARDEA, Swains.

300.—*A cinerea*, Lath.—*A. major*, Gmel.—*Kabood*, H.—*Common Heron.*

The European *Heron* is found all over India throughout the year, frequenting tanks and rivers. It is generally solitary, but is occasionally met with in parties of 4 or 5 together. It breeds in the more wooded districts on the top of lofty tress, during the hot weather, generally 4 or 5 nests being placed together. Length 3 feet; bill at front $5\frac{2}{10}$, at gape $6\frac{1}{2}$; tarsus $6\frac{1}{2}$; centre toe and claw $4\frac{3}{4}$; hind do. $2\frac{1}{2}$.

301.—*A. purpurea*, Auct. also *A. purpurata.—Naree*, H.—*Purpled Heron.*

This species is much less numerous, and less generally spread than the

last one. I have seen it most abundant in the wooded western coast in the wet paddy-fields. It is also a permanent resident in India, but I have not yet seen its breeding places.

Irides yellow; bill brown above, yellow beneath; legs yellow, brown in front. Length 30 to 32 inches; bill to front $4\frac{8}{10}$ths inch, at gape nearly 6; tarsus 6; centre toe and claw nearly 6; hind toe $3\frac{1}{2}$.

Sub-Genus EGRETTA, Briss. Swains.

302.—*E. flavirostris.*—*A. flavirostris*, Temm. and Wagl.—*A. Torra*, Buchanan and Franklin.—*A. egretta*, Sykes' Catal.—*Mullung Buglah*, H. —also *Turrur Buglah.*—*Larger Egret*—*yellow-billed Egret.*

This bird appears to have been first described as distinct by Buchanan (according to Franklin), who named it *A. Torra*—and when without the appendages, *A. putea.* It has, however, been since named by Temminck with a more scientific appellation, which I have therefore adopted.

The large yellow-billed *Egret* is tolerably abundant in most parts of India, frequenting rivers, tanks, marshes, and the inundated paddy-fields.

Length nearly 3 feet; bill at front 4 inches, at gape 5; tarsus $5\frac{1}{2}$; bill yellow; legs black.

303.—*E. alba.*—*A. alba*, Gmel., Lath. and Wagler?—*A. Egretta* of Temm. and others?—*Puttoka Buglah*, H.—*Large black-billed Egret.*

Though I have not hitherto obtained specimens of the large *Black-billed Egret*, I have on several occasions observed it in different parts of the country, always alone. It is probably the *Egret* of Europe, said to be found in numbers in Central Asia.

304.—*E. Garzetta.*—*A. Garzetta*, Auct.—*Keerchea* (or *Kilcheeah*) *Buglah*, H.—*Small Egret.*

This *Egret* abounds over all the Peninsula, occasionally associating in numerous flocks, and frequenting rivers, tanks, paddy-fields, pools of water, &c. &c.

Irides light yellow; bill black; legs do.; feet greenish yellow. Length about 2 feet; bill at front $3\frac{2}{10}$th inch; at gape 4; tarsus 4. It is said by the natives that the bones of this bird, if reduced to powder, and a little employed in the cooking of bony fishes, render the fish bones quite soft, so that they can be eaten with satisfaction!!

305.—*E. asha.*—*A. asha*, Sykes.—*A. jugularis* of Forster and Wagler?.—*Kala Buglah*, H.—*Small blue Heron.*

This is a comparatively rare bird. I have seen it but once or twice solitary in small rivers, in the northern part of the table land. My only specimen differs somewhat from Colonel Sykes' description, in having the whole under surface of the body grey, dashed slightly with white on the neck and lower part of the body, chin and throat alone are pure white. It appears to resemble much the description of *Ard. jugularis*, but Sykes pronounces his bird distinct, so for the present I place my specimen under his appellation, as the only recorded similar Indian species. Mr. Elliot in his notes says, " Is common on the western coast at the mouths of rivers."

Irides light yellow; bill brownish horny above, yellowish beneath; legs greenish black; feet greenish. Length about 2 feet; bill at front $3\frac{1}{2}$; at gape $4\frac{2}{10}$ths; tarsus 4.

306.—*E. Javanica.* Sw.—*A. Javanica*, Horsf.—*A. Scapularis*, Wagl. —*Kunchur Buglah*, H.—*Indian Green Heron.*

This pretty little *Heron* differs according to Horsfield and Swainson from the closely allied South American bird (*Ard. Scapularis*) in the comparative length of the toes, and in the legs being feathered close down to the knee. It is only found solitary on the banks of wooded streams, perching in general on a low branch overhanging the water. It is spread over all the Peninsula.

Irides light yellow; bill blackish above, yellowish horny beneath; legs dark green; feet yellow; lores light green. Length 17-18 inches; tarsus nearly 2; bill to front $2\frac{4}{10}$ths, at gape $3\frac{1}{2}$.

307.—*E. Malaccensis.*—*Ard. Malaccensis*, Auct.—*A. Grayii*, Sykes, Hardw Ill. Ind. Zool.—*A. affinis*, Horsf. ?—*A. Coromandelica*, Lich. ?—*Buglee*, H. also *Undhe Buglee.*—*Marroon-backed Heron* or *White winged Heron.*

The supposed new species of Colonel Sykes, named by him *Ard. Grayii*, I have ascertained to be the summer or breeding plumage of the common *Ard. Malaccensis.* It begins to moult in April or May, and resumes its plain winter livery about September or October. Perhaps the most remarkable circumstance connected with this is the change of colouring the bill undergoes, from the usual plain dusky tint to the three coloured hues it presents during the hot season.

The *Buglee* is a very common and familiar bird, frequenting rivers, tanks, marshes, wet paddy-fields and pools of water—and often seen in the rivers, feeding among crowds of people, bathing and washing, with-

out any alarm or suspicion. It is often struck down by a trained Shikra (*Accip. Dukhunensis*).

Irides light yellow; legs and feet light greenish. Length 19 inches; bill at front $2\frac{1}{2}$, at gape $3\frac{2}{10}$ths; tarsus $2\frac{3}{10}$th inches.

308.—*E. Caboga.*—*Ard. Caboga*, Pennant.—*A. ruficapilla*; Vieill. ?—*A. russata*, Wagler ?—*Dorreah Buglah*, H.—*Soorheah Buglah* of some.—*Cattle Heron.*

This well known species is generally found in flocks of various size in company with herds of cattle, feeding on grasshoppers, and other insects disturbed by them whilst grazing. It seldom resorts to water like its other congeners, except during the heat of the day. Like the last, it assumes its beautiful golden or ruddy tint on head, neck and back, only during the breeding season.

Irides bright yellow; bill dark yellow; legs and feet blackish. Length about 20 inches.

The specific name is derived from the Hindustani '*Gao Buglah*', meaning *Cow Heron.*

Sub Genus BOTAURUS, Briss.—*Bitterns.*

309.—*B. cinnamomeus.*—*Ard. cinnamomea*, Gmel.—*Lal Buglah*, H. of some.—*Little Chestnut Heron* or *Bittern.*

I have only found this little species at all common on the wooded regions of the western coast, generally in marshy ground, or in the wet paddy-fields. I have also seen it on the banks of the Pykarra river on the Neilgherries, and Mr. Elliot mentions it as common in parts of Dharwar.

Length about 15 inches; bill at front 2, at gape $2\frac{7}{10}$ths; tarsus $1\frac{9}{10}$ths,

310.—*B. Stellaris*, Briss.—*Nir Goung*, H.—*Common Bittern.*

I have not myself hitherto procured a specimen of the *Bittern*, but know that it has been killed near Jaulnah and Aurungabad, in marshy ground. It is enumerated, moreover, both in Sykes' Catalogue and by Mr. Elliot, and the latter gentleman has lately shown me a fine specimen shot on the Neilgherries, during the hot season.

Sub Genus NYCTICORAX, Steph.

311.—*N. Europæus.*—*Ard. nycticorax*, L.—*Wākh*, H.—*Night Heron.*

The *Wākh* is of universal occurrence throughout the Peninsula,

but most common in the more wooded regions. It roosts during the day on high trees, often in palm groves, and sallies forth to the waters in the neighbourhood after sunset to feed upon fish, frogs, and other aquatic animals. It breeds on palm and other trees, many nests together. Its Hindustani name is derived from its harsh call.

Irides crimson. Length 21 to 23 inches; tarsus 3; bill at gape 4, at front $2\frac{8}{10}$ths.

Genus PLATALEA, L.

312.—*P. leucorodia*, L.—*Chumuch Boozah*, H.—*White Spoonbill.*

The *Spoonbill* is tolerably abundant over India, frequenting rivers and tanks, occasionally in numerous flocks, and feeding on various aquatic insects, *crustacea*, small fish, &c.

The Hindustani name signifies '*Spoon Ibis*,' and I think from its manner of feeding, its small gape, and its flight, the *Spoonbill* shews more affinity to the *Ibis* family than to that of the *Herons*, with which most authors associate it.

Genus CICONIA, Briss.—*Storks.*

Besides the *Mycteria*, already separated from the *Storks*, there appear to be three types (which might be made into as many sub-genera) among the Indian *Ciconiæ*. One is represented by the *white Stork*, a second by the *black Stork*, and a third by the *carrion eating Storks*, or *Adjutants*. The *white-necked stork* appears to be a link between the *white* and *black Stork*, as well in form as in its habits, being partly terrestrial, and partly aquatic in its habits.

313.—*C. alba*, Briss.—*Lug-lug* or *Oojlee*, H. also *Hajee Lug-lug.*—*White Stork.*

The *white Stork* is found, though rarely, throughout India, during the cold weather only, feeding in large flocks on the open dry plains on grasshoppers, beetles, and other land insects, also on lizards and small snakes.

Irides brown; bill, legs and feet red.

314.—*C. leucocephala.*—*Ard. leucocephala*, Auct.—*Cic. umbellata*, Wagler.—*Kalee*, H.—*Manukjor*, in Hindostan.—*White necked Stork.*

This handsome *Stork* is a permanent resident in India, breeding on high trees in the more wooded parts of the country. In its habits it

partakes somewhat of both the *Cic. alba*, and *Cic. nigra*, being, though perhaps most generally found about rivers, streams, marshes and tanks, often seen feeding on the open dry plains, or on bare cultivated ground. It feeds alike on fish, frogs, crabs and other aquatic food, and on grasshoppers, beetles, and other land insects.

Irides dark scarlet, surrounded by an external narrow ring of pale yellow; bill black, dark red at the edges and point; naked skin of the face black; legs red. Length 30 to 34 inches; bill at front 6½-7.

315.—*C. nigra*, Auct.—*Soormaee*, H.—*Black Stork.*

This, like the *Oojlee* is also migratory, being only found in the Peninsula during the cold season. It is a rare bird, and generally seen solitary near tanks, rivers, and small streams, feeding on fish, frogs, and various aquatic insects, and their larvæ. A good *Bhyree* will strike it down, and it is eagerly sought after for this purpose.

Orbits naked and red; bill deep red; irides brown; legs brownish red. Length 3½ feet; expansion of wings 6 feet; bill at front 7½ inches; tarsus 8¼.

316.—*C. Argala*, Steph.—*Ard. dubia*, Gmel.—*Cic. Marabou*, Temm. —*Adjutant* of Calcutta.

I have but once seen this enormous bird during the early part of the monsoon in the table land near Jaulnah, but did not obtain it.

317.—*C. nudifrons.*—New species ?.—*Dusta*, H.—*Black-mantled Adjutant.*

Descr.—Plumage above glossy black; the greater coverts pale dusky brown, edged with whitish, beneath pure white. Bill, frontal plate, and occiput, dirty greenish; head, neck and gular bag, reddish pink above, yellowish beneath; head, neck, and as far as the end of the gular bag, covered with strong scattered hairs, or rather hair-like feathers. Irides light greyish brown or grey; feet blackish; forehead, only, naked and horny. Length 4½-5 feet; bill at gape 11½ inches, 2 inches broad beneath at the base; 3 inches high at base; tarsus 11; tibia 15; tail 12; wing about 30; face, throat and lower part of neck with numerous black spots; gular bag when *stretched* about 6 or 7 inches long.

This species is tolerably common in the northern portion of the Dekhan, more especially during the monsoon. It is usually solitary—occasionally in parties of 4 or 5. It descends like the *Vultures* on any carcasses, or stalks about the plains, sometimes close to cantonments, picking up reptiles, insects, and garbage of any description.

318.—*C. calva.*—New species ?—*Chinjara*, H.—*Crab-eating Adjutant.*

Descr.—Above glossy black, with purple and green reflections ; the feathers of the back and coverts obsoletely marked with numerous black bars ; greater coverts dark brown ; tertials and scapulars, bottle green, edged with white ; beneath pure white ; bill dirty greenish ; head perfectly naked and horny. A thick tuft of hairs on the occiput, and a few scattered hairs on the neck. Has no gular pouch. Length 4½ feet ; bill 11½ inches ; much more slender than in the last. Breadth at base beneath 1½ ; height at do. 2½ ; tail nearly 12 ; tarsus 10 ; wing 25 inches. I found the stomach of one crammed with crabs, and a few large grasshoppers.

The under tail coverts of the 3 last species are known under the name of *Marabou* feathers, and are highly prized, and much sought after.

Sub Genus MYCTERIA, L.

319.—*M. Australis*, Lath.—*M. Asiatica*, Lath. ?—*Bunarus*, H.—*Large black* and *white Stork.*

This gigantic looking bird is rare in Southern India, being found singly occasionally in tanks and large rivers. It lives on fish, frogs, and various other aquatic animals. Its length of limb gives it the appearance of being a much larger bird than it really is. The young bird has the neck light brown, and very downy, and the colours much less vivid throughout ; the irides also dark brown.

Irides yellow ; bill black ; legs rosy red. Length 4½ feet ; expansion about 7 feet ; bill 13 inches ; tarsus 13½ ; weight about 11 lbs.

Genus HÆMATOPUS, L.

320.—*H. ostralegus*, L.—*Durya Gujpaon*, H. i. e. *Sea Longshanks* (*Himantopus*).

This bird is included in Mr. Elliot's Catalogue, having been found by him on the western coast, towards the more northern part of the Peninsula, and I have since heard of its having been procured as far to the southward as Mangalore.

Family TANTALIDÆ.—Ibis.

Genus ANASTOMUS.—Ill.—*Open beak.*

321.—*A. typus*, Temm.—*Ard. Coromandelica* and *Ard. Ponticeriana*, Auct.—*Goongloo* or *Goonglah*, H.—*Indian Shell Eater.*

This curious bird is tolerably common in those parts of the country where tanks and marshes abound. It lives in flocks of various size or solitary, and feeds on fish, frogs, and various other aquatic animals, but chiefly when procurable, on shell-fish (a species of *Unio*), the breaking of the shell of which to get at the contents, is the cause of the open space or gape between the mandibles, which does not exist in the young birds. Colonel Sykes I see, however, appears to think that the gape exists originally in the young bird, and that it is a provision of nature to effect the opening of the shells, on which it feeds. From my own observations, however, corroborated moreover by Mr. Elliot's, I am inclined to think that the former is the more correct opinion, viz. that the open space is caused by the constant attrition of the mandibles on the hard testaceous covering of the shell-fish. The *Goongloo* frequently perches on trees, and breeds, I am informed, on lofty trees.

Irides bright yellow; bill dark greenish; orbits and pouch, naked and black; legs greenish, with a shade of pink; middle claw, with a sharp edge internally, but not serrated. Length 32 inches; expansion of wings 4½ feet.

This bird flies tolerably rapidly, and with more quickly repeated strokes of its wings than any of the *Heron* family, with which it has generally been placed by systematists.

Genus TANTALUS, L.

322.—*T. leucocephalus*, Lath.—*T. Indicus*, Cuv.—*Dŏkh*, H.—*Jaunghul*, in Hindostan.—*Pelican Ibis.*

The *Pelican Ibis* (as it may be named) is common over all India, frequenting rivers, tanks, pools and marshes, generally in parties more or less numerous, and feeding on fish, frogs and aquatic insects, and also according to Sykes, on vegetable matter. It perches freely on trees, and breeds on lofty trees, during the hot weather and monsoon. During the heat of the day, they may be seen standing motionless in the water knee-deep, digesting their morning's meal. They are said to feed a good deal, during the night. The scapulars assume their most beautiful rosy tinge, during the hot weather, or breeding season. The *Bhyree* strikes this bird always on the head, its mandibles being sharp, and inflicting a severe cut.

Irides yellowish brown; bill, naked face and crown, and chin pouch, deep ochre or orange yellow; legs pale dirty pink. Length 3½ feet; expansion of wings about 6 feet; bill (at gape) sometimes nearly 1 foot.

Genus IBIS.

323.—*I. Macei,* Cuv. and Wagl.—*I. religiosa,* of Sykes' Cat.—*Tant. melanocephalus* of Lath.—the young bird.—*Moonda,* H.—*Suffeid Boozah* of some.—*Black-headed Ibis.*

The Indian *Black-headed Ibis,* is generally supposed to be a different species from the one found in Egypt, and which was held sacred, and embalmed by the ancient Egyptians. Colonel Sykes, however, asserts their identity. This bird is found in tanks, rivers, marshes, wet paddy-fields, &c. in flocks of various size, and feeds on small fish, frogs, crabs, shrimps, and a variety of insects, both water and land, for it is occasionally seen feeding on the dry ground, near rivers and tanks. It is found at all seasons, and therefore most probably, breeds in this country, though I have not yet seen its nest. Inside the bone of the wings is covered by a bright red skin, as in the *Cic. leucocephala.* The young bird has the head and neck partly covered with small white feathers, and is therefore, as Wagler imagines, the *Tant. melanocephalus* of Latham.

Irides lake red; bill, naked head and neck, and feet black. Length 30 to 34 inches; bill at gape about 7; tarsus 4; weight 3½ lbs.

324.—*I. papillosa,* Temm. P. C.—*Boozah,* H.—*Kala Boozah* of some. —*Warty-headed Ibis.*

This bird is of common occurrence throughout India, being found in numerous flocks, feeding on the open plains, chiefly on grasshoppers, beetles, and other land insects, also few even on water insects, frogs, &c. It breeds on trees in the neighbourhood of water, sometimes alone, but at times in numerous parties. Colonel Sykes says correctly "Soar high in the air, uttering melancholy screams." It makes a long flight with a *Bhyree,* and requires a good one to capture it.

Irides light red; bill brownish red; legs dirty brick red; papilla of the crown and occiput, bright red—naked skin on which they are placed black. Length 25 to 30; bill at gape 6; tarsus 3; weight 3¼lb.

325.—*I. falcinellus,* Temm.—*I. igneus*—young bird of the 2d year, according to Wagler.—*Kewaree,* H.—*Glossy Ibis.*

As I have always shot the so called *I. igneus* in company with the other species, I am induced to agree with those who consider it as the young bird of the *I. falcinellus.*

The *Glossy Ibis* frequents shallow water at the edge of tanks and rivers—also marshes and wet paddy-fields. It is always found in flocks,

and feeds on frogs, shell-fish, shrimps and various insects, and their larvæ, both aquatic and terrestrial.

Irides brown ; bill and legs dark olive green ; a whitish skin goes round the base of the bill, the eyes and the gape. Length varies from 22 to 26 inches ; of a full grown male, the bill is nearly 6 inches ; and tarsus $4\frac{1}{2}$.

Family RALLIDÆ.—Rails, &c.

Genus PARRA, L.—*Peeho*, H.—*Tank-runner.*

326.—*P. Indica*, Lath.—*P. œnea*, Cuv.—*P. melanchloris*, Vieill.—*P. superciliosa*, Horsf.—*Indian Tank-runner.*

This curious bird is found over most of the Peninsula, in tanks covered with weeds, and water lilies, on the leaves of which it runs with great facility. It feeds chiefly on seeds, and other vegetable matter.

Bill green at the base, yellowish at the tip ; legs dark green. Length about 1 foot ; bill to posterior end of frontal plate $1\frac{3}{4}$; tarsus $2\frac{8}{10}$ths ; centre toe and claw $4\frac{1}{2}$; hind do. 4.

327.—*P. Sinensis*, Gmel., Gould. Cent. Him. Birds.—*Golden-necked Tank-runner.*

This handsome species, is perhaps, more generally spread than the last, but not so numerous, except in some few localities. It frequents, like the last, weeded and lily-covered tanks, but is also often to be seen feeding at the edges of rivers and tanks, totally devoid of weeds. Feeds on seeds, also on shells and water bugs.

Irides deep brown ; bill and legs olive green. Length 22 inches ; tail $11\frac{1}{2}$; tarsus 2 ; middle toe and claw 3 ; hind do. 2 ; bill at front 1.

Genus PORPHYRIO, Briss.

328.—*P. smaragnotus*, Temm.—*Gall. poliscephala*, Lath.—*Keima*, H. —*Sultana Coot* or *Purple Coot.*

This handsome bird is tolerably common on most of the weedy and grassy tanks, throughout the country, especially when covered with the lotus, walking easily on the leaves, and feeding chiefly on seeds and vegetable matters.

Irides blood red ; bill and frontal plate, cherry red ; legs pale brick

red ; wing spur also reddish. Length 18 inches ; bill at gape $1\frac{1}{2}$; tarsus $3\frac{8}{10}$; middle toe and claw nearly 5 ; hind do. $2\frac{1}{2}$.

Genus FULICA, L.—*Coot.*

329.—*F. atra*, L.—*Dasree* or *Dasurnee*, H.—*Bald Coot.*

The *Common Coot* of Europe is a common and abundant bird on most of the Indian tanks, even on those that dry up during the hot months. Lives chiefly on vegetable matters.

Irides blood red ; bill and frontal plate white ; legs green reddish at the sides ; feet leaden coloured. Length nearly 18 inches.

Genus RALLUS, L.—*Rail.*

330.—*R. Gularis*, Horsf. ?—*R. cærulescens*, Lath. ?—*Blue-throated Rail.*

The species of *Rail*, of which I give a description below, is found in reeds and long grass, by the sides of tanks, rivers and water-courses. I have only seen it in Travancore and Cochin, but it is also enumerated in Mr. Elliot's Catalogue, as found in Dharwar.

Descr.—Crown, top of the head and nape, deep chestnut, diverging into two streaks on the back of neck ; chin white ; cheeks, sides of neck, throat and breast, light leaden ; back, beneath, and wings dark brownish, with a strong olive gloss, and numerous narrow white transverse bars, most numerous on the abdomen and thighs.

Bill sanguineous at the base, and diaphanous, brownish at the tip ; legs brown, with a reddish tinge. Length about 11 inches ; wing $4\frac{8}{10}$; tarsus $1\frac{6}{10}$; bill at front $1\frac{2}{10}$.

331.—*R. rufescens*, Vieill. ?—*R. Philippensis.* ?—*R. striatus.* ?—*R. Ceylonicus.* ?—*Larger brown rail.*

I procured a single specimen of a *Rail* near Cochin, which I cannot refer exactly to any described species, but which appears to approach some of the species named above. I add a brief description : head deep brown ; above olive brown ; the feather edged with pale yellowish rufous ; cheeks and sides of neck fawn ; chin and throat white ; beneath pale fawn, with numerous transverse dark marks ; middle of abdomen white ; shoulder with a tinge of cinereous and edged white. Length 14 inches ; wing 7 ; tarsus $2\frac{1}{2}$; tail 3 ; bill at the front, including frontal plate $1\frac{1}{2}$.

Genus GALLINULA.

332.— *G. akool*, Sykes.—*Indian Water Hen.*

This common bird is found chiefly in reeds and long grass, by the sides of tanks, rivers, and water-courses, and is flushed with difficulty.

I have seen specimens exactly like those described by Sykes, others in which the chin was entirely black,—and others in which there was much white, extending down the middle of the abdomen. These were all from different localities, but most probably, were only different ages of the same bird. There may, however, be several varieties, or it may be distinct species. Length nearly 1 foot; bill at gape 1 inch; tarsus $1\frac{7}{10}$; middle toe and claw nearly 3; hind do. $1\frac{2}{10}$.

333.—*G. Javanica*, Horsf., most probably the same as the *G. phœnicura.*—*Dawuk*, H.—*White-cheeked Gallinule.*

This handsome bird is by no means uncommon in many parts of the country, though seldom seen in some districts. It frequents bushes in the neighbourhood of water or marshy spots—also gardens and hedges in dry ground. Found both solitary, and in parties of 5 and 6. Feeds upon insects of various kinds, both land and water.

Irides red; bill green, whitish at the tip; legs greenish yellow; dusky behind. Length 12 inches; bill at gape $1\frac{1}{2}$; tarsus $2\frac{2}{10}$ths; middle toe and claw $2\frac{3}{4}$; hind do. $1\frac{2}{10}$ths.

Family SCOLOPACIDÆ.—*Snipes and Sand-pipers.*

Genus SCOLOPAX, L.

Sub Genus RHYNCHÆA.—Cuv.

334.—*R. picta*, Gray, Proc. Zool. Soc.—*R. capensis*, Auct.—*Painted Snipe* of Europeans in India.

The *Painted Snipe* is a permanent resident in India, being found at all seasons in suitable ground, viz. the grassy edges of tanks, marshes, inundated paddy-fields, and the usual haunts of the common snipes. It, however, appears in much greater numbers at the commencement of the cold season, along with the other snipes, so probably the greater number breed towards the more northern part of India. This has, probably,

led Colonel Sykes and others to consider it as migratory. I have, however, seen it throughout the hot weather and monsoon in two successive years, and find the same fact stated by Mr. Elliot.

Irides dark brown; bill dusky reddish; legs green. Length about 9 inches; bill 2; tarsus $1\frac{8}{10}$ths.

Sub Genus SCOLOPAX.

335.—*S. rusticola ?—S. minor ?—S. saturata*, Horsf. ?—*Neilgherry Woodcock.*

I find it impossible from the meagre descriptions of authors, to ascertain whether this bird is identical with the European bird or not, or whether, as some have supposed, it may be the American species, from its smaller size. It appears to correspond in plumage pretty closely with the European bird, but from the examination of a good number of fresh specimens, it seems to be a considerably lighter bird. It arrives on the hills about November; a stray bird or two being sometimes killed in October, and leaves in March.

Length 15 to 16 inches; wing $8\frac{1}{4}$; bill at front 3 to $3\frac{2}{10}$ths; tarsus $1\frac{8}{10}$ths; tail $3\frac{1}{4}$; average weight about 9 or $9\frac{1}{2}$ oz.; varies from 7 to 11 oz.

336.—*S. nemoricola,* Hodgson, Journ. Asia. Soc. No. 66.—*Solitary Snipe* of the Neilgherries.

This bird differs considerably from the solitary snipe of Europe (*S. major*, L.). It is a rare visitant to the Neilgherries during the cold season, and has not, as far as I am aware, been killed elsewhere in the Peninsula. It frequents the marshy ground at the foot of the dense woods of the hills. I obtained a specimen from J. Scott, Esq. of the M. C. S. which is about 13 inches long, the bill being 2 $\frac{6}{10}$ths.

337.—*S. gallinago*, L.—*Bhuruk* or *Buruk*, H.—*Common Snipe.*

The *Snipe* is found in great numbers all over the Peninsula during the cold season, frequenting grass by the sides of tanks, and streams, marshes, but more especially the inundated paddy-fields.

338.—*S. gallinula*, L.—*Jack Snipe.*

The *Little Jack Snipe* is tolerably abundant along with the last in some parts of the country, especially towards the more northern part of the Peninsula.

Sub Genus LIMOSA, Briss. and Swains.—*Godwit.*

339.—*L. leucophœa ? ?.*—New species ?—*Chaha*, H.—*Large Godwit.*

This bird, which, in absence of more precise information, I have referred to the European *Godwit*, though strongly suspecting it to be distinct, is a rare visitant to the Peninsula, during the cold weather, and frequents the shallow water at the edge of large tanks. I add a brief description.

Above ashen grey, darkest on the back and rump; beneath white, ashy on the neck, breast and sides; upper tail coverts white, black tipt; tail white at the base, the rest black, with a narrow black tip. Length 20-21 inches; bill 5; tarsus 4; wing 9; tail $3\frac{1}{4}$; bill reddish white, dusky at the tip; legs and feet greenish black.

340.—*L. melanura ?.*—*Chota Chaha*, H.—*Lesser Godwit.*

I have only seen this species on two or three occasions, at the edges of tanks, on the northern part of the table land. As I am by no means certain, that it is the same as the European bird, I also add a description of this one. Plumage above brown; the feathers edged with fawn; head, neck and breast, pale ashy brown; throat white; tail black, white at the base; tail coverts as in the last. Length of one specimen 17 inches; bill 3 $\frac{4}{10}$ths; tarsus $2\frac{1}{2}$; wing 8; tail $2\frac{3}{4}$.

341.—*L. terek*, Horsf.—*S. terek*, Lath.—*Limicola Indiana*, Vieill.

I have only seen this curious bird on one occasion at the edge of the Trichoor lake. Length nearly 9 inches; bill 1 $\frac{8}{10}$; wing 5; tail 2; tarsus $1\frac{1}{10}$ths; bill blackish, green at the base; legs orange.

Sub Genus TRINGA, L. Swains.

342.—*T. Hardwickii.*—*Limosa Hardwickii*, Gray and Hardw. Ill. Ind. Zool.—*Gehwala*, H.—*Large brown Sand-piper.*

I can find no description of this handsomely plumaged *Sand-piper* in any of the works I possess. It appears, however, to be the same as the species figured in Gray and Hardwicke. It is one of the first that make their appearance here, at the commencement of the cold weather. I have seen them in the middle of September, and as late as the end of March. It frequents the edges of large tanks in numerous flocks. I add here a brief description. Plumage above brown, of various shades of intensity, each of the feathers edged with pale brown, or whitish, or in some with rufous fawn; head and neck paler; face, throat, and plumage beneath white, ashy on the neck and breast. In those specimens killed

earliest in the season, the colour of the back is most intense brown, and the feathers are broadly edged with rufous. The neck and head too are tinctured with rufous; tail ashy pale brown, some of the centre feathers barred at the tip with black and white.

Length 12-13 inches; bill 1 $\frac{3}{10}$; tail $2\frac{1}{2}$; wing $7\frac{1}{4}$; tarsus 2; legs fleshy, ochrey colour; weight about $6\frac{1}{4}$ ounces.

343.—*T. Indica.—Tot. Indicus*, Gray and Hardw., Ill. Ind. Zool. ? ?

This very closely resembles the last, and indeed only differs in size, weighing little more than half of the last. As, however, I have found it of the same size throughout all the cold weather, and the species of *Sand-piper* in general are very uniform in size, I have ventured to place it as a distinct species.

Length $9\frac{1}{2}$-$10\frac{1}{2}$; wing 6; tail 2 $\frac{2}{10}$; bill 1 $\frac{2}{10}$; tarsus 1 $\frac{6}{10}$; weight about $3\frac{1}{2}$ to 4 ounces.

344.—*T. subarcuata ?*

I have only seen this *Tringa* once or twice, frequenting the sides of tanks in the northern part of the Peninsula.

Length about 8 inches; wing 4 $\frac{6}{10}$; tail 2; tarsus rather more than 1; bill deep black; legs greenish brown.

345.—*T. pusilla ?.—Chota pun-loha*, H.

I have found this bird all over India, frequenting rivers, sides of tanks, and inundated paddy-fields, in numerous flocks.

Bills and legs black; irides dark brown. Length 6 inches; wing 3 $\frac{8}{10}$ths, a little longer than the tail, which is somewhat above $1\frac{1}{2}$; bill at front $\frac{7}{10}$ths; tarsus $\frac{9}{10}$ths.

346.—*T. Temminckii*, Leister ?

Not nearly so common, I think, as the last species, to which it is closely allied, and has the same habits.

Bill greenish at the base, black at the tip; legs green, with a tinge of reddish. Length $6\frac{1}{4}$; wing 3 $\frac{8}{10}$; tail nearly 2; bill $\frac{7}{10}$; tarsus $\frac{7\frac{1}{2}}{10}$ths.

Genus HIMANTOPUS, Briss. and Swains.

Sub Genus RECURVIROSTRA, L. *Avoset.*

347.—*R. Avocetta.*—European *Avoset.*

I have only seen this curious bird at the edge of a large tank at the extreme north of the Peninsula, but I have seen stuffed specimens killed as far south as Madras.

Irides red brown; bill black; legs French grey. Length 18 inches; bill 3 $\frac{3}{10}$; tarsus 3¼.

Sub Genus HIMANTOPUS.—*Longshanks.*

348.—*H. melanopterus*, Auct.—*Guj-paong*, H.—*Common Longshanks* or *Stilts.*

Very common all over India, during the cold weather, not leaving till April, frequents rivers, tanks and marshes in numerous flocks. A few couple probably remain here the whole season, as I have seen them as late as June, in pairs on the banks of wooded streams and reedy tanks.

Sub Genus TOTANUS, Sw.—*Sand-piper.*

349.—*T. glottoides*, Vigors, Gould's Century of Himalayan Birds.—*Timtimma* or *Toomtomma*, H.—*Indian Greenshanks.*

Found solitary all over India in rivers, brooks and tanks. Is a wary bird, rising with a very shrill and loud cry—hence its Indian name.

Irides dark brown; bill greenish black; legs pale olive. Length 14; bill 2$\frac{2}{10}$ths; wing 7; tarsus 2½; middle toe 1$\frac{6}{10}$ths.

350.—*T. Horsfieldii.*—*Limosa Horsfieldii*, Sykes.—*Chota Timtimma* H.—*Lesser Greenshanks.*

This, like the last, is in general found solitary, but much more rare. I have, however, seen it in very large flocks at the Trichoor lake.

Irides dark brown; bill blackish; legs pale olive green. Length 10 inches or 10½; wing 5½; tail 2½; tarsus 2$\frac{3}{10}$ths; bill to front 1$\frac{6}{10}$ths; weight 3 ounces.

351.—*T. fuscus?*—*Butan*, H.—*Large red-legged Sand-piper.*

Whether this is the species to which I have temporarily referred it or not, can only be determined by actual comparison. I have found this bird very rarely in the Peninsula of India, and only towards the more northern portion of it, by the side of rivers or tanks, and solitary. Specimens killed towards the end of the cold season in April, had assumed the dark summer plumage.

Irides dark brown; bill brown, red at the base beneath; legs orange red. Length 14 inches; wing $6\frac{1}{2}$; tail $2\frac{1}{2}$; bill $2\frac{3}{10}$ths; tarsus $2\frac{3}{10}$ths.

352.—*T. calidris*, Auct.?—*Chota Butan*, H.—*Redshanks.*

As the bird I am now speaking of, is about the same length, and answers nearly to the description of the European *Redshanks,* I have for the present referred it to that bird. I have only obtained a single specimen of this *Sand-piper,* shot at the edge of a tank in the northern part of the table land.

Irides dark brown; bill brown; legs orange red. Length $10\frac{1}{2}$-11 inches; wing 6; tail $2\frac{4}{10}$ths; bill $1\frac{6}{10}$ths; tarsus $1\frac{8}{10}$ths.

353.—*T. glareola*, L.

Found in small parties, or sometimes solitary at the edges of tanks, rivers, brooks and pools of water, common every where. Length 9 inches.

354.—*T. Ochropus.*

Almost always found solitary, occasionally in parties of 3 or 4, in the same localities as the last, and still more common.

Length 10 inches.

355.—*Hypoleucos.*

Found solitary in similar situations with the 2 last species, but not nearly so common.

Length 8 to $8\frac{1}{2}$ inches; wing $4\frac{1}{2}$; tail $2\frac{2}{10}$ths; tarsus 1; bill nearly 1; bill brown, greenish at base beneath; tarsus pale green.

Genus STREPSILAS, Ill.—*Turnstone.*

356.—*S. interpres*, Auct.—*Common Turnstone.*

I obtained a pair of these prettily marked birds at the tank of Jaulnah, 200 miles inland, in the month of April, and have since seen specimens procured as far to the southward as Madras.

Irides dark brown; bill black; legs orange. Length 9 inches; wing 6; tail $2\frac{1}{2}$; tarsus nearly 1 inch; bill at front $\frac{9}{10}$ths.

9

Genus NUMENIUS, Briss.—*Curlew.*

357.—*N. arquata.*—*Goungh*, H.—*Curlew.*

I obtained a single specimen of the *Curlew* at the edge of a tank, near

Jaulnah. It is enumerated also in Mr. Elliot's Catalogue as found in Dharwar.

358. *N. phæopus.—Chota Goungh*, H.—The *Whimbrel.*

I saw the *Whimbrel* in considerable numbers at the Chilka lake, and have also seen it on the sea coast, near Madras, and in various other places. Mr. Elliot says, 'Found every where along the sea-shore, and mouths of large rivers.'

Family CHARADRIADÆ.—*Plovers.*

Genus CHARADRIUS, L.

359.—*C. pluvialis*, L.—*Golden Plover.*

The *Golden Plover* is but rarely met with in the Peninsula. I have only seen it on two or three occasions on the banks of large rivers on the table land, and on grass plains, near the sea coast—usually in small flocks of 5 or 6. I have seen specimens killed in the neighbourhood of Madras, in the breeding plumage viz. with the whole under surface of the body deep black. It therefore, most probably, breeds in this country.

360.—*C. Philippensis*, Lath. ?—*Zirreah*, H. of some.—*Common ringed Plover.*

This pretty little bird is found not only at the sides of rivers, and tanks, but also, and perhaps more generally, in the open dry plains, in flocks of various size, running rapidly along the ground, and picking up various small insects. I have found it all over the Peninsula.

Irides deep brown; bill black; legs yellowish; orbits bright yellow. Length $7\frac{1}{4}$; wing $4\frac{3}{4}$; tail $2\frac{1}{2}$; bill at front $\frac{1}{2}$ inch; tarsus nearly 1.

361.—*C. minor*, Wagl. ?—*C. hiaticuloides*, Frankl?.—*Lesser ringed Plover*

This species differs but little from the last. It is smaller—has the upper plumage of a darker shade, the quills also much darker, the tertials less lengthened, the lateral tail feather have more white, and the base of the lower mandible is yellow.

I have only found it at the northern part of the table land, at the edge of rivers.

Irides deep brown; bill black, yellow at the base beneath; legs yellow; orbits deep yellow. Length hardly $6\frac{1}{2}$; wing 4; tail 2; bill to front $\frac{4}{10}$; tarsus $\frac{8}{10}$ths.

362.—*C. cantianus.* ?—*C. ruficapillus*, Temm. ?—New species.?

I have found this *plover* at the edge of rivers and tanks, at the northern part of the table land, and also more lately by the side of salt-water inlets, and the sea shore on the east coast, during the hot season in June.

As I am uncertain of its being the European species indicated, I shall give a brief description.

Forehead, eyebrows, face and beneath, pure white; a narrow line from the gape, passing through the eyes and ears, cinereous; a narrow blackish band behind the white forehead; crown of head and nape ferrugineous; plumage above cinereous; external tail feathers pure white; no naked skin round eyes; bill black; legs greenish yellow.

Length 7 inches; wing 4 $\frac{3}{10}$; tail 1 $\frac{8}{10}$; bill at front $\frac{6}{10}$; tarsus rather more than 1 inch.

363.—*C. russatus.*—New species. ?

Descr. Forehead, streak on either side, extending through the eyes, ears, and meeting behind, and a broad pectoral band deep brownish black; top of the head, back and wing coverts of the usual brown cinereous hue of the *Ringed Plovers*; band above the eyes, encircling the head, except in front, and plumage beneath white; wing coverts edged with white; quills and medial tail feathers, dark brown; external tail feathers white, with a brown band which almost disappears on the outermost feather; scapulars deep marroon colour; upper tail coverts, tinged with rufous; bill yellow with black tip; orbits bright yellow; legs orange yellow.

Length 6½ inches; wing 4½; tail 2 $\frac{2}{10}$; bill at front nearly $\frac{6}{10}$ths; tarsus rather more than 1 inch.

I procured a single specimen of this apparently new species of *Ringed Plover* at the edge of the Pulicat lake near Madras, in the month of June. Its distinguishing feature is the marroon colour of the scapulars. Whether this is a permanent mark, or, as I conjecture may be the case, only assumed during the breeding season, I am at present unable to determine.

Genus VANELLUS.—*Lapwing.*

364.—*V. bilobus.*—*Charadrius bilobus*, Gmel. and Wagler.—*Zirdee*, H.—*Yellow wattled Lapwing.*

This *Plover* is found throughout India, usually frequenting the dry stony plains, or open sandy downs in small flocks, and feeding on various insects. Has a feeble cry, which Colonel Sykes renders as "*Deewit Deewit.*" I found the eggs of this bird on one occasion on a grass plain, on the west coast, in the month of September. They were of a light salmon colour with dusky spots, 4 in number, and laid on a slight depression of the ground.

Irides silvery grey ; bill black, yellow at the base ; naked skin yellow ; legs do. Length nearly 12 inches ; wing $8\frac{1}{4}$; tail $3\frac{2}{10}$; tarsus $2\frac{4}{10}$; bill to front 1 inch.

365.—*V. Goensis.*—*Tringa Goensis*, Lath.—*Char. atrogularis*, Wagler.—*Teteehree* (vulgo *Teetooree*), H.—*Red wattled Lapwing.*

This well known bird is common throughout most of India, single occasionally, but usually in small parties. It frequents the land in the neighbourhood of water, feeding on various insects, chiefly water ones, shells, &c. It has a loud shrill cry, something like '*Did he do it*,' or as others say '*Pity to do it.*' This call is much heard at night, even in places where none were seen during the day. It is often very annoying to sportsmen, hovering over him, and uttering its shrill cries for some distance.

The *Teteehree* is said by the natives to sleep with its legs upwards, and the Indian proverb '*Teteehree se asman thama jaega*,' or can the *Teteehree* support the Heavens ? is applied to a person who undertakes something far above his strength.

Irides red ; bill at the base and fleshy skin, lake red ; tip of bill black ; legs yellow. Length nearly 13 inches.

366.—*V. ventralis.*—*Charad. ventralis*, Gray and Hardw., Ill. Ind. Zool.—*C. coronatus*, Vieill. ?

I obtained a single specimen of a bird which appears to be the young or female of the one figured in Gray and Hardwicke, at the edge of a large tank near Jaulnah. It answers the description too (with the exception of the black spot on the abdomen) of *Wagler's C. ventralis*, but that bird is described among the 3-toed *Charadrii.* My bird has a hinder toe, though a very small one.

This bird is evidently a link joining the *Vanelli* to the *Œdicnemi*, its bill being larger and more robust than that of most *Vanelli.*

Irides dark brown ; bill and legs black. Length 13 inches ; wing $8\frac{1}{2}$; tail $3\frac{1}{2}$; tarsus $2\frac{3}{10}$; bill to front $1\frac{2}{10}$ths.

Genus ŒDICNEMUS, Cuv.

367.—*Œ. crepitans*, Temm.—*Char. Œdicnemus*, L.—*Burseree* or *Kurwanuk*, H.—also sometimes *Lumbee.*—*Bastard Florikin* of English.

The *Thick-kneed-plover* of Europe is found all over the Peninsula, and remains the whole year. It frequents the open stony plains—also bushy tracts, and open spaces in jungly districts. Found in pairs, or in small parties. When approached, it often conceals itself behind a bush or stone, and sometimes squats close to the ground, and is with difficulty seen. It feeds on various insects chiefly, also sometimes on seeds of various kinds. It wanders much at night, and has a peculiar long shrill piping note; seldom heard except at this time—its usual cry, being a single harsh creaking note. The *Shikra* (*Accipiter Dukhunensis*) is often flown at this bird. Its flesh is of excellent flavour, and much esteemed by some.

Irides pale greenish yellow; legs pale olive. Length 16-17 inches; wing 9; tail $4\frac{1}{2}$; tarsus $3\frac{4}{10}$; bill at front $1\frac{1}{2}$; weight about 12 to 13 oz.

368.—*Œ. recurvirostris*, Swains., Lardn. Cycl.—*Aubee*, H.

This curious bird which has been lately accurately described by Swainson, is by no means common, and is only found by the sides of the larger rivers, and tanks, and salt-water inlets, in pairs, sometimes two or three pairs together. It feeds on various aquatic insects and their larvæ. Its cry of alarm is a loud harsh creaking note, and like the last species, it occasionally squats, when approached.

Irides pale yellow; bill black, yellow at base; legs yellowish green. Length 20 inches; wing 11; tail $4\frac{1}{2}$; bill to front $2\frac{6}{10}$ths; tarsus $3\frac{1}{4}$.

Genus TACHYDROMUS, Ill.

Sub Genus GLAREOLA, L.—*Swallow Plover.*

369.—*G. Orientalis*, Leach.—*Lesser* or *square-tailed Swallow Plover.*

This neatly plumaged little bird is rare in most parts of Southern India. I have seen it occasionally in pairs, by the sides of tanks, running briskly along the edge, and picking up various small insects. I on one occasion saw a large flock of them, apparently migrating from one district to another, it was in the month of September, and near the extreme south of the Peninsula.

Irides dark brown; bill black; gape dark red; legs black. Length $7\frac{1}{4}$ inches; wing beyond tail $1\frac{6}{10}$ths; from base 6; bill at front $\frac{4}{10}$ths; tarsus $\frac{9}{10}$ths.

370.—*G. torquata*, Temm.—*Fork-tailed Swallow Plover.*

I have seen this bird but very rarely in small flocks, or pairs, by the edges of tanks or rivers, feeding chiefly like the last, on various aquatic insects and larvæ, especially on *Nepæ*. On one occasion, I saw a numerous flock of them flying low over some grain fields, apparently capturing insects on the wing. Its flight is remarkably swift, and swallow-like, as is that of the last species.

Irides dark brown; bill and legs black; the posterior portion of the gape red. Length 11 inches, of which the tail is $4\frac{3}{4}$; wing $7\frac{1}{2}$; bill at front $\frac{1}{2}$ inch; at gape nearly 1 inch; tarsus 1 $\frac{3}{10}$ths.

Sub Genus TACHYDROMUS, Ill.—Cursorius, Lath.—*Courier Plover.*

371.—*T. Asiaticus.*—*Char. Coromandelicus*, L.—*Nookree*, H.—*Indian Courier Plover.*

The *Courier* is very numerous towards the more northern part of the table land, much less so towards the south. It frequents the open bare plains only, in numerous flocks, running along with great celerity, and picking up various insects, beetles and small grasshoppers and their larvæ. It breeds in the more retired spot during the hot weather, laying 3 eggs of a pale greenish yellow colour, much blotched, and spotted with black, and also with a few olive spots. They are deposited in a slight hollow.

Irides deep brown; bill black; legs creamy white, as if coated with paint. Length varies from $8\frac{1}{2}$ to nearly 10 inches; wing 6; tail $2\frac{3}{10}$; bill at front $\frac{8}{10}$; tarsus $2\frac{2}{10}$. As I have frequently killed birds of various length from the same flock, I fancy that Swainson's supposed new species *T. Orientalis*, said to differ only in size from the *T. Asiaticus* of authors, must be abandoned.

Sub Genus AMMOPTILA, Sw.

372.—*A. charadroides*, Sw. ?—*Sand Plover.*

A bird of this remarkable genus is mentioned in Mr. Elliot's Catalogue, but without any description, so I am uncertain if it is the same species as

the one indicated by Swainson, in his Synopsis. Mr. E. mentions his having found it in flocks on the sea-shore, on the west coast of India.

Bill black ; legs and feet plumbeous. Length 15 inches.

Ord. NATATORES.—*Swimmers.*

Family ANATIDÆ.—*Ducks.*

Sub Family PHÆNICOPTINÆ,—Sw.

Genus PHÆNICOPTERUS.—L.

373.—*P. Europæus.—P. ruber*, L.—*Bug Huns*, H.—*Rajah Huns* of some.—*Flamingo.*

The *Flamingo* is found throughout the Peninsula, in large rivers and tanks, though not a very common bird. I saw it in the greatest abundance in the large Chilka lake, on the low flat islands of which I have seen many hundreds congregated together. It feeds on vegetable matter, and minute water insects, &c. and much gravel is in general found in its stomach. It is tamed, and kept at Hydrabad by some of the nobles of that city, and fed on grain of various kinds. I think Swainson is perfectly justified in placing this bird among the ducks, from its external structure alone, and I see that its internal anatomy fully confirms this view. In fact the natives of India recognize its alliance with this family, by calling it *Heron Goose* or *King Goose.*

Bill pink, black at the tip ; legs pale rose coloured ; irides pale golden yellow. Length 3½ to 4 feet.

374.—*P. minor.—Lesser Flamingo.*

I have seen a flock of this bird at the Jaulnah tank, last cold season, and am informed by Shikarees, that it pays an annual visit here, about Christmas.

Sub Family ANSERINÆ.

Genus ANSER, *Antiq.*

375.—*A. Indicus*, Lath., Gould Cent. Him. Birds.—Indian or *Barred-headed Goose.*

This *Goose* is not so common in Southern India, as it appears to be in Bengal, and the more northern Provinces. I have seen it in pairs in August, within a few miles of Cape Comorin, and once or twice in flocks of 15 or 20 in large tanks, on the central table land.

Genus DENDROCYGNA, Sw.—*Tree Ducks.*

376.—*D. Awsuree.*—*Mareca Awsuree*, Sykes' Cat.—*Anas arcuata*, Horsf. Java.—*Sillee*, H.—*Whistling Teal* of Europeans.

As my specimens agree exactly with the description of Sykes, of his *M. Awsuree*, and also the description in Mr. Elliot's Catalogue, I think it may be considered distinct from the Javanese bird. It is found in numerous flocks, in various parts of the country, most abundant, perhaps, in the wooded districts, frequenting tanks, and often seen perched on the boughs of trees that overhang the water. I have not seen its breeding places.

Length about 18 inches; bill to front $1\frac{1}{2}$; tarsus $1\frac{6}{10}$; centre toe and claw $2\frac{3}{4}$; wing 8; tail $2\frac{1}{2}$; bill and legs plumbeous; irides brown; eyelids, bright yellow. It is not esteemed good eating.

377.—*D. major.*—New species ?—*Large Whistling Teal.*

I am strongly inclined to consider this as a distinct species from the last. It differs in its larger size, in the whole head, neck and under parts, being rufous or chestnut, and not so dark in the belly as the former bird. The upper tail coverts are yellowish white, instead of deep chestnut. There is a blackish line down the back of the neck from the nape. The tip of the head is deep chestnut instead of brown, and there is a broad patch round the centre of the neck, in which the feathers are somewhat hackled or lanceolate, whitish at the tip, and blackish at the base. The feathers of the loins are highly elongated, chestnut on one side of the shaft, and creamy white on the other side, broadly edged with dusky.

Length 20-21 inches; wing $9\frac{1}{4}$; tail $2\frac{1}{4}$ inches; tarsus 2; bill at front $1\frac{8}{10}$ths; centre toe and claw $3\frac{1}{2}$.

378.—*D. ? girra.*—*Anas girra*, Gray and Hardw., Ill. Ind. Zool.—*A. Coromandelica.*—*Geerjah*, H.—*Cotton Teal* of Europeans in India.

This pretty little bird is not very common in Southern India, and like the last, abounds most in the more wooded districts, and it is said to breed in some of the forests of the western coast. It has a peculiar

changing note, not unlike that of the *Grouse*, which it generally keeps up whilst flying. It is found both in pairs and flocks—sexes alike.

Irides bright crimson; bill black; legs greenish ochrey yellow, blackish in some. Length 13 inches; weight 9 ounces.

This bird, by its bill, appears to approach the *Dendronessæ* of Swainson.

378. bis.—*D. affinis.*—New species ?—*Girree*, H.

This species or variety, is mentioned in Mr. Elliot's notes as differing from the last in the permanent want of the collar in both sexes and at all ages.

Length nearly 14 inches.

Genus PLECTROPTERUS, Leach.

379.—*Pl. melanotos*, Steph.—*Anas Melanotos*, Gmel.—*Nooktah*, H. also of the Mahrattahs.—*Bronze-backed Goose*—*Comb-Duck*, (Sykes) of the Residents in the Madras Presidency.

This splendid bird is found all over India, in tanks and rivers, though not very abundant. It breeds during the monsoon in most of the wooded districts, and as I am informed, in long grass, near rivers or tanks. The female is much less than the male, and wants the large protuberance at the base of the bill. It feeds on various seeds and vegetable matters—also on paddy, jowaree, and other grains. The flesh is hard, and not held in much esteem. Length of male 34 inches; wing 16; tarsus 3; bill straight to gape 2¾: height of protuberance above 2 inches, from the edge of the mandible, length of do. at the centre nearly 2. Female from 26 to 28 inches long.

Irides dark brown; bill and protuberance black; legs greenish plumbeous; weight nearly 6-lb.

Sub Family ANATINÆ, Sw.—*River Ducks.*

Genus MARECA, Leach.—*Widgeon.*

380.—*M. fistularis*, Steph.—*Anas Penelope*, L.—*Common Widgeon.*

Common in the cold weather throughout India in the rivers and tanks, found in large flocks.

Irides dark brown; bill light plumbeous, black at the tip.

Genus ANAS, L.

Sub Genus CHAULIODUS, Sw.

381.—*C. strepera*, Sw.—*Anas strepera*, L.—The *Gadwall.*

Not so numerous as the last, but by no means rare—only found in the cold season.

Irides brown ; bill blackish, reddish at the sides and lower mandible ; legs and feet ochrey yellow.

Sub Genus ANAS.

382.—*A. clypeata*, L.—*Tredaree*, H.—*Shoveler.*

Common over all India, in flocks during the cold weather.

Irides yellow ; bill black ; legs orange ; bill of female brown, reddish beneath.

Sub Genus BOSCHAS, Sw.

383.—*B. circia.*—*A. circia*, L.—*Garganey Teal.*

Common throughout the cold weather, being one of the first to arrive in the country, sometimes before the end of September.

Irides brown ; bill black ; legs greenish plumbeous.

384.—*B. crecca*, Sw.—*A. crecca*, L.—*Common Teal.*

Common along with the last.

Sub Genus DAFILA, Leach.

385.—*D. caudacuta.*

Tolerably abundant towards the more northern parts of the Peninsula, rare in the south, found in large flocks.

Bill plumbeous, with a black line down the centre, also at edges ; legs plumbeous.

Irides dark brown.

Genus TADOMA, Leach.

386.—*T. rutila*, Steph.—*A. casarca*, L.—*Soorkhab*, H.—also *Chukwa.* —*Ruddy Shieldrake.*—*Brahminy Duck* of Europeans.

This large duck is, like the last one, less common towards the south, than in the more northern parts of the Peninsula. Is frequently seen in pairs, or small parties of 4, 5 or 6, but occasionally, as in the Chilka lake, in numerous flocks of some hundreds. Only found, as far as I can learn, in the Peninsula, during the cold weather. Colonel Sykes, however, appears to think that they are resident in India, throughout the whole year. Found much on rivers. Mr. Elliot in his notes says "Found in pairs, often several pairs together, shy, uttering a peculiar deep note which has a strong resemblance to deeply intonated *ā-oung*." The Hindoos consider them the models of conjugal tenderness. The flesh is held in no esteem in this country.

Irides dark brown; bill and legs black.

387.—*T.? pœcilorhyncha.*—*A. pœcilorhyncha*, Gmel.—*Gurm-pace*, H. *Spotted-billed Duck.*—*Large Grey Duck.*

This fine duck is most common in the more wooded parts of the country, and is a permanent resident, breeding in retired places and marshy spots, among the jungles, during the hot weather.

Irides brown; bill black, yellow at the tip, red at the base; legs deep red. Length 2 feet to 26 inches; tarsus 2¼; weight about 3-lbs. Is excellent eating. I am by no means certain, that it is a true *Tadomer*, being perhaps a species of *Boschas*, or *Chauliodus*; but the elevation of the bill at the base, has induced me to consider it as a *Tadomer*. I on one occasion found a couple of small fish in the gizzard of this *Duck*, besides vegetable matter and gravel.

368.—*T.? cayophyllacea.*—*Pink-headed Duck*, Lath.

Though I have not yet seen this *Duck*, I venture to include it in my present Catalogue, from the concurrent testimony of several Shikarees, who described it, so as to leave no doubt in my mind of its being the species named as above. It is said to be an occasional, though very rare visitor to the rivers and tanks of the country, about Jaulnah, during the cold weather only.

Sub Family FULIGULINÆ, Sw.

Genus FULIGULA.

389.—*F. rufina*, Stephens.—*Red-headed Pochard.*

Not very common in the Peninsula, generally in small parties in the cold weather.

Irides deep yellow.

390.—*F. cristata*, Steph.—*A. fuligula*, L.—*Tufted Duck.*

Tolerably common throughout the Peninsula, during the cold weather. It is one of the latest to quit the country, and I have on one occasion found a single one in the month of June, in a tank near Hydrabad.

Irides bright yellow; bill plumbeous; legs blackish. Length 19-20 inches.

391.—*F. nyroca.*—*A. leucophthalmos.*—*Bechstein.*

Rare in the Peninsula, generally in pairs, or very small parties in tanks. Irides greyish white. These 3 last species dive remarkably well.

Family COLYENBIDÆ.—*Grebes.*

Genus PODICEPS, Lath.

392.—*P. Philippensis*, Steph.—*Choorakah*, H. ?—*Indian bay-necked Grebe.*

Common in the tanks all over India, even in those which dry up early in the season. Feed on various water insects, &c.

Irides ochrey yellow. Length 9½ inches.

392, *bis.*—*P.* ——— ?—*Lesser Grebe.*—*Pun-doobee*, H. ?

I have hitherto not procured this little species of *Diver*, which is mentioned in Mr. Elliot's Catalogue, though without any description, but I have seen it on several occasions, in grassy tanks, and among weeds. It appears much smaller than the common one.

Family PELECANIDÆ.

Genus PLOTUS, L.—*Darter.*

393.—*P. melanogaster*, Gmel.—*Banwah*, H.—*Darter* or *Snake bird.*

Not very uncommon in the Northern Circars, and in other districts where tanks abound. Feeds on fish chiefly, swims and dives with great rapidity, and as Colonel Sykes remarks, has the faculty of being enabled to swim with the whole of its body under water, the long head and neck being alone visible, looking like a snake.

Length about 3 feet; tail 9½; bill front $3\frac{3}{10}$ths.

Genus CARBO, Mayer and Swains.—*Cormorant.*

394.—*C. Javanicus*, Horsf.—*Phal. Africanus* ?—*Joghrabee*, H.—vulgo *Pun-kowa*—i. e. *Water crow.*

Very common in all the tanks and rivers of India. Feeds on fish, and is very voracious.

Irides crimson ; bill black, reddish at base beneath ; legs black.

I may state that I have specimens, shot in company with many others of the same plumage, which have the wing coverts and scapulars blue grey, margined with black, and in the belly and neck, having much white in their plumage, mixed with dusky blackish.

Length 23 ; tail 6 inches ; bill at front 1 $\frac{1}{10}$th.

395.—*C. Cormoranus.*—*Pelicanus Carbo*, L.—*Gho-ghur*, H.

This is much more rare than the last. I have only seen it on the wooded Bhowany river, at the foot of the Neilgherries, and once or twice in the northern part of the table land, in large tanks. I have seen it in the month of June, as far inland as Hydrabad, so it most probably remains here the whole year and breeds. Mr. Elliot mentions it in his Catalogue, and I learn from him that it is far from being uncommon in parts of the Southern Mahratta Country, and that it may sometimes be seen in considerable numbers, sitting on trees in the neighbourhood of tanks.

Length 2 feet 10 inches ; bill at front $2\frac{1}{4}$; weight $4\frac{1}{2}$ lbs.

Genus PELICANUS, L.

396.—*P. onocrotalus*, L.—*Hawaseel*, H.—The *Pelican.*

The *Pelican* is tolerably common in many of the tanks all over the country, even very far inland, occasionally perches on lofty trees.

Sub Family LARIDÆ.—*Gulls* and *Terns.*

Genus STERNA, Swains.

Sub Genus STERNA, L.—*Sea Swallow*, or *Tern.*—*Kaghuzee*, H.

397.—*S. melanogaster*, Temm.—*S. acuticauda*, Gray and Hardw., Ind. Zool.

This *Tern* I have found all over the country, frequenting tanks, and more especially rivers.

398.—*S. similis*, Gray and Hardwicke, Ill. Ind. Zool.

Found in the same localities as the last, and still more common and numerous.

Length $11\frac{1}{2}$ inches; wing $9\frac{1}{4}$; tail 3 $\frac{3}{10}$th; bill at front 1 $\frac{1}{16}$th: tarsus $\frac{9}{10}$th; bill dark lake colour; feet and legs black.

399.—*S. Seena*, Sykes.

Spread throughout all the Peninsula, but less common than the last.

Bill bright yellow; legs red. Length 17 inches; wing 11; tail $8\frac{1}{2}$; bill at front $1\frac{1}{2}$.

400.—*S. anglica*, Montagu.—*Marsh Tern.*

Common all over the country.

Length about 16 inches; but it varies a good deal in size: of one 16 inches long, the wing is $13\frac{1}{2}$, $2\frac{1}{2}$ inches beyond the tail, which from base is nearly 6; bill and tarsus black.

401.—*S. minuta*, L.

I have seen this pretty little *Tern* most abundant in the west coast, at the mouths of rivers, but have also met it above 200 miles inland.

Length nearly 9 inches; wing $6\frac{1}{2}$; half an inch beyond the tail, which is nearly 3; bill at front $1\frac{2}{10}$; yellow, dusky at the tip; legs orange; tarsus $\frac{7}{10}$ths.

402.—*S.* ——— .—New species?

Descr. Head and back of neck sub-crested deep glossy black, plumage above light grey; beneath white; tail much forked; lateral feathers white; bill yellow; legs black.

Length $17\frac{1}{2}$; wings $12\frac{1}{2}$; 1 inch beyond tail; tail $6\frac{1}{2}$; bill (at front) 2 $\frac{3}{10}$ths; tarsus 1 inch.

I have only found this very elegant species on the sea coast, on the west of India, at the mouths of rivers.

403.—*S.* ———.—New species?

Back, wings and tail pale grey; rest of body white, except a blackish grey streak through the eye; head and neck with a tinge of grey.

Length $14\frac{1}{2}$ inches; wing 11; tail 4; bill at front 1 $\frac{3}{10}$th; tarsus $1\frac{1}{2}$ bill black, within orange red; legs and feet dusky sienna reddish.

This species appears tolerably common on the east coast of the Peninsula, near Madras.

404.—*S.* ———.—New species.

Descr.—Head and nape blackish; feathers edged with white; body above grey, beneath white; bill deep lake red; legs sienna.

Length 11 inches; wing $8\frac{1}{2}$; tail 3; bill at front 1 inch.

Genus THALASSITES, Swains.

405.—*T.* ———.—New species ?

Descr.—Head and upper part of the neck glossy black, above light grey; beneath, and tail white; bill orange red; legs black.

Length 21 inches; wing 16, reaching 3 inches beyond the tail, which is $5\frac{1}{2}$; bill at front 2 $\frac{6}{10}$th; tarsus 1 $\frac{8}{10}$th.

I have found this large *Tern* most abundant on the west coast of India, at the mouths of rivers, but also far inland, frequenting tanks. The young bird differs in the head being spotted white and black, instead of being pure black.

Genus LARUS, L.—*Gull.*

406.—*L. brunnicephalus ?*.—New species ?.—*Brown-headed Gull.*

Descr.—Hood pale ashy brown, terminated by a darker edge; mantle and wings light grey; the rest of the body pure white; bill and legs deep lake red; a half circle of white feathers round the back part of the eye.

Length 19 inches; wing 14; tail nearly 6; bill at front $1\frac{1}{2}$; tarsus 2.

I have found this *Gull* common on the west coast of India, and also inland above 200 miles, frequenting rivers and tanks. A *Gull* which corresponds exactly in size with this one, and which I have usually seen in company with it is probably the young bird. It differs in wanting the brown hood, and in the tail being broadly tipped with black.

407.—*L.* ———.—New species ?

I possess only a young specimen of this *Gull* in the usual mottled plumage, so shall content myself with giving its measurements. It was shot 200 miles inland.

Length 2 feet; wing 18 inches; tail 8; bill (front) 1 $\frac{8}{10}$th; tarsus 2 $\frac{6}{10}$th; bill and legs yellowish.

I have seen other species of *Gull* on the sea coast, but not having procured specimens, refrain from noticing them at present.

I have now brought to a conclusion this imperfect Catalogue, the chief object of which has been an enumeration of all the birds found in Southern India; the few brief notes I have added having been hastily drawn up, without method, to relieve the monotony of a bare list of names. I purpose in a future, and I hope, an early number, to add a supplement, containing the description of a few additional species I have obtained since the first parts of the Catalogue were printed—and also to correct several errors of nomenclature, and to add some brief additional notes on the habits and geographical distribution of a few of the species, which more recent and extended observations have enabled me to offer.

The specimens on which my Catalogue was founded, are now on their way home to a distinguished Ornithologist, and as soon as they are examined, and identified by him, I will in another supplement give the result of his examination, and a synopsis of all the species with their correct names and synonymes. By way of rendering this part more generally useful, I may probably also add a synopsis of the different genera found in India, and a brief description of all the species, so that it may serve as a text book for the Peninsular birds, and supply to the ornithologist in this country, the want of the numerous bulky and ill-compiled works of reference, which often perplex as much as they inform.

I trust also to be able to add to this, through the kindness of Walter Elliot, Esq., a list of the names of many of the birds in several of the native languages, and in the native characters, by which collectors may be much facilitated occasionally, both in the acquisition and identification of various species. At a future period, I hope that my observations on the habits and manners of many of the Indian birds may be so far extended as to enable me to publish a much more full and enlarged account than I am now able to attempt, and illustrated by coloured figures of many of the unfigured species. To enable me, however, to effect this, I look confidently for the assistance and co-operation of other observers, without which it will be impossible to present any thing like a tolerably complete history of Indian Ornithology; for, from the nature of a tropical climate precluding much or constant exercise on the open air, and the necessary occupations of most of the residents here, no one individual can ever expect to give from his own observations a faithful transcript of the habits and manners of even a limited number of the birds; and it is only from a series of detached observations, and from many individuals co-operating together, that such a much wished for result can be obtained.

With this view, I earnestly solicit any of the readers of this Catalogue, (who may have the opportunity and inclination), to forward me any observations they may make, and let them not deem the smallest scrap of information too trifling to send. I would more particularly request further intelligence regarding the nidification of the Indian birds, of which so little is known, their various notes, food, and manner of feeding, times of appearance and disappearance of migratory species, names in any of the native languages, and any tales, proverbs or superstitious ideas the natives may have concerning them. There are also a few desiderata which I shall here enumerate, and any individuals who may have it in their power to give any information regarding them, will receive my best thanks.

No 6.—Specimen of the large *Fishing Eagle* of the Chilka lake, which I suspect may be the *Hal. ichthyætus*, No. 8 of the Cat.

No. 34.—Specimen and descriptions of the *Besra.*

Specimen and description of the *Kandesrah* of Indian Falconry, a species of *Sparrow-hawk*, I suspect, nearly allied to the *Besra.*

Specimen or description of the *Gorbesrah* which I suspect is the same as my No. 36, a species of *Goshawk*, differing in its smaller size from the *Baz* or true *Goshawk.*

No. 268. *bis.*—Whether the *Ortygis Taigoor*, of Sykes, is a distinct species, or the young bird of the *O. pugnax.*

No. 282.—Any information regarding the *Black Florikin*, its time of appearance in different districts, at what season it is seen in a state of change, &c. &c. &c.

II.—*On the General Application of Low Steam Power to all Vessels, instead of Sails.*

It is very surprising that though so much has been done in applying Steam Power to move vessels at high speeds for the conveyance of passengers, it does not appear that as yet, any considerable trials have been made of it, for the conveyance of merchandize at moderate rates. The quantity of fuel and power of engine requisite to propel a ship at high speeds is so great, that for a voyage of any considerable length, the vessel is almost taken up with them, leaving so little room for merchandize that it will not answer, except principally employed in the transport of passengers. But this is no reason that it should not answer to use

steam for the transport of merchandize at low rates, and the subject is well worthy of investigation. The question is, whether merchandize can be transported at the *rate* it is at present conveyed by sailing vessels, cheaper or safer by steam ; or whether it can be conveyed at the same *cost* as in sailing vessels, but quicker by steam.

It seems strange to conclude, that, because it will not answer to use steam for the common purposes of commerce at high speeds, therefore it will not be advisable to use it at moderate rates. On land, horses are used at high speeds for passengers, and at low rates for goods, and on examination it may be found to be just the same with Steam Power at sea. The two cases are in effect precisely similar ; in moving land conveyances the resistance at higher speeds does not increase, but animal power rapidly diminishes, which is the cause of the rapid increase of cost. In steam vessels, there is indeed no less of power at higher speeds, but the resistance to a vessel moving through the water rapidly increases, and hence the effect is the same as in land conveyance ; viz. a rapid increase of expence. In the one case, there is no increase of resistance, but a decrease of power as the speed increases ; in the other there is no decrease of power, but there is an increase of resistance. Hence upon the first glance at the subject, it would appear probable that as it is found to answer on shore to use horses for passengers at high speeds and for goods at low ones, so it may be found in the case of steam afloat.

The best way of attempting to arrive at a sound conclusion in this case, is, to compare the actual cost of the two modes from the data we have, and then to consider what further important points there are in the matter, which it is not so easy to make subjects of calculation.

But it may be well first to consider the leading principles, which affect the motion of vessels through water. It is well ascertained that up to about 8 knots, an hour, the resistance of water to vessels increases more rapidly than in the proportion of the square of the velocity ; that is, with a double velocity resistance is more than four times as great, with a treble velocity more than 9 times as great and so on. Hence to move a vessel a certain distance, it takes more than four times as much fuel and more than four times the power of engine to do it at a double speed, and more than 9 times as much fuel and steam power, to do it at three times the rate. This appears to hold good up to a certain speed, about 8 knots an hour, after that the resistance does not increase quite so rapidly, but still in rather a greater proportion than the velocity. Hence if a vessel can carry sufficient fuel to go 4000 miles at the rate of ten knots she can carry enough to go about 12,000 at 5 knots, and more than 50,000 miles at 2½ knots. But further, as in going at the double speed the engine must

not only overcome more than a proportional resistance, but also do it in half the time, the actual power of engine employed for 10 knots speed must in fact be about 6 times the power of that required for 5 knots or about 10 times, what is necessary for 4 knots, though it will only be in action half and two-fifths the time respectively, in accomplishing the same distance.

Hence if a vessel of 400 tons required at 10 knots an hour an engine of 180 horse power, and 50 tons of coal per 1000 miles, she would at 5 knots an hour require an engine of 30 horse power, and $8\frac{1}{3}$ tons of coal for that distance; and at 4 knots, an engine of 18 horse power and 5 tons of coal for the same. This has been proved by experiments in many ways, to be about the proportionate power required for the speed.

And with respect to the effect of the size of the vessel, it is also well known that the resistance to a large vessel is less in proportion than to a small one, that is, if a vessel for instance of 1600 tons, required an engine of 400 horse power for any given speed, or one horse power to every 4 tons, a vessel of $\frac{1}{8}$ that size, or 200 tons, would require double that proportion, or 100 horse power, being 1 horse power to every 2 tons; the cause of this is obvious, that the body of water to be removed by any vessel is in proportion to the breadth and depth multiplied together, but her capacity is in proportion to the breadth, depth and length multiplied together. Thus a vessel of double dimensions will displace four times as much water in moving, and consequently meet with four times the resistance, but her capacity will be increased 8 fold, so that while she carries 8 times as much cargo, she only meets with 4 times as much resistance, and consequently requires in proportion to her tonnage, only half as much power. It is on this ground, that large vessels are found to answer better as steamers than small ones, and it was because this principle was forgotten, that it was so confidently asserted, that in the present state of the knowledge of steam navigation, a vessel could not carry fuel enough to cross the Atlantic, the calculations being made from small vessels without allowing for this consequence of an increased size.

Hence we find that in steam navigation, the same vessel requires for a double speed more than double the quantity of fuel, and about six times as powerful an engine to *go a certain distance.* The same vessel to go *for a certain time* at a double speed, requires about six times the quantity of fuel, and six times the power of engine, but she will go in that time double the distance. For a given speed, a vessel of eight times the tonnage as another, will only require four times as much fuel, and four times as great a power of engine.

These points are so well known and have been so often ascertained practically, that it is not necessary to attempt the proof of them here.

The point that remains is simply to estimate from these principles and from the known cost of the various items in sailing and steaming, which would be cheapest at different rates of speed, to work a vessel by sails or by steam.

For this purpose the actual cost of working a vessel of 380 tons, new measurement, in the Indian seas for near two years may be taken, as a subject for comparison.

EXPENCES OF A SAILING VESSEL.

First class vessel of 380 tons new measurement, above an average sailer, and working well, carrying 400 tons of a mixed cargo.

COST.

Hull	3600 £
Fitting for sea in every respect	2400
Total cost	6000 £

EXPENCES.

	£
Insurance at 6 per cent	360
Commander	360
1st Officer	120
2d do.	72
4 Sucunnies (helmsmen)	120
Syrang and 2 tindals	66
China carpenter	48
Butler and boy	24
28 Lascars	336
Victualling 38 persons	47
Renewing sails	80
Do. spars	40
Repairing hull, 2½ per cent. (*including coppering*)	90
Sundries, paint, &c	50
Port charges	200
Replacing hull, 3 per cent	108
Steam tug hire	30
Total expences per annum	2151 £

The actual distance run by above vessel measuring the nearest line from port to port was 26,500 miles, in 23 months, or 13,800 miles per annum; and the number of days actually under way was 303, giving 88 miles distance per day, or 3¾ knots per hour, for the average of a good sailing vessel in the Indian seas, allowing only the real distance between the ports, which is done in order to compare her distances with those of a steamer.

EXPENCE OF STEAMING.

Vessel of the same capacity, viz. measuring 380 tons, and capable of carrying 400 tons of a mixed cargo, but built of course upon the model of a steam vessel, that is with greater length and less draught of water, propelled by a 30 horse engine.

COST.

	£
Hull	3,400
30 Horse engine, &c.	1,200
Anchors and cables.	200
Set of lug sails and moveable masts, in case of accidents.	200
Total cost	5,200£

Expences.	£
Insurance at 4½ per cent	234
Commander	360
Officer	120
Engineer	300
2d Do.	120
Armourer	120
6 Stokers	72
1 Syrang, 1 tindal, 10 lascars	168
China carpenter	48
Butler and boy	24
Hired labour in port in consequence of the small crew.	100
Victualling 21 persons	24
Repairing hull 2 per cent.	108
Renewing engine 9 per cent.	108
Repairs of engine 5 per cent	60
Oil.	12

Steaming 15,100 miles at 108 per day, at 8-lbs of coals per horse

power, per hour, 350 tons at 16 shillings............	280
Total expence per annum.	2380
Deduct an account of 800£ less capital than in the case of the sailing vessel, int. at 4 per cent..	32
Total expense of steaming 15,100 miles.......	2348
Do. of 13,800 miles, the distance run by the sailing vessel in a year.	2150 £
Expenses of sailing vessel same distance.	2150 £

That is by the above estimate, the expences of working the vessel by steam and by sails is precisely the same. It remains to calculate the loss of tonnage and consequently of freight that would be the consequence of carrying the engine and fuel.

The average length of voyage made by the above vessel was 1800 miles each ; supposing the steamer to carry on an average, coal for 2400 miles, or 23 days, she would require, of coals.... .... 58 tons.

Weight of engine........ .. .. 20 tons.

Total.......... 78

But as she would require scarcely any space for sails, and the various stores of a sailing ship, we may deduct on that account, especially as her upper deck will be quite clear........... 40

Actual loss of feight caused by engine......... 38 tons.

Further, as the sailing vessel would not be full every voyage, but probably be at least 38 tons deficient in an average of her voyages, the steamer would in effect suffer no loss compared with the sailing vessel in carrying her engine and fuel.

It is next necessary to ascertain what would be the comparative speed on the two systems ; it has been before shown that the speed of the sailing vessel averaged $3\frac{3}{4}$ miles per hour, and it must be remembered that this vessel averaged considerably above merchant vessels in general. The power of steam allowed is 30 horse for a vessel of 380 tons new measurement, which would be sufficient to propel her at 5 knots per hour, in smooth water and calm weather ; she would then go

6 with a strong leading wind and following sea (without sails), and 3 against a strong head wind ; and in case of a gale of wind she would easily go a head 2 knots keeping the sea on her bow. Her average then in the Indian seas could not be reckoned at less than $4\frac{1}{2}$ knots or 108 miles per day, while a fast sailing vessel only averaged $3\frac{3}{4}$ knots, the speed of the steamer would therefore be greater by $\frac{1}{5}$, or she would perform a voyage in 48 days, which the sailing vessel would not perform in less than 60 days. The steamer, it is to be observed, carries no standing masts or rigging whatever, but merely 3 light masts with lug sails which she can set up in case of accidents. Whether it might be worth while to use those sails regularly in the trades or in any leading winds, is a subject for further calculation.

For the safety of the two modes, there can be no room for doubt that the steamer having no masts and sails, would be free from most of the dangers to which sailing vessels are exposed ; she would in fact be always in that state to which sailing vessels are obliged to reduce themselves when they have no alternative, in order to avoid destruction, viz. by cutting away their masts.

The conclusion therefore is, that it would be quite as cheap to work a merchantman by steam at $4\frac{1}{2}$ knots per hour, as by sails at $3\frac{3}{4}$ knots in voyages of moderate length, that is not exceeding on the average 2,400 miles, or varying from 1,000 to 4,000 miles without taking in coal, and that it would be far safer.

But in the above comparison, ordinary voyages only are supposed.

To show more strongly the effect of steam power, we may take the case of a voyage in which the vessel was delayed by accidents, such as frequently occur to sailing vessels ; this vessel lately sailed from Singapoor to Madras ; on her passage she lost one or two of her masts in a white squall, and was obliged to put back into Penang ; and on her making Madras, she encountered so strong a current that she was carried to lee-ward of her port ; and in consequence she was 80 days in completing her voyage.

Comparison of profits of a steamer with the Ship ——— from Singapoor to Madras.

Time occupied in voyage	80 days
Add for loading and discharging	10
Total time of voyage..............................	90 days

Total expence of such a vessel per annum........2151£

Do. for 3 months................ .....£538
Actual receipts of the same vessel...... 700

Net profits........ .... 162£

Do. per annum .... 650£

which upon 6,000£ is.. .... 11 per cent.

Calculation for steamer.

Expences (inclusive of coal)—per annum............2,100£

Do. for 3 months...... ...... 525 £

F U E L.

	Miles.
Madras to Penang....................	1,300
Penang to Madras (in part)	1,000
Madras to Penang	1,300

Coal for miles........ ....3,600 at $2\frac{1}{4}$ tons
for 100 miles, 82 tons at 17 Rupees...... 140
Penang to Singapoor (4 times).........1,500 miles
Penang towards Madras..................... 300

Wood for.......... ....1,800 miles
at 5 tons, per 110 miles, 80 tons at 2 Rs. 16

Total expences for 3 months .... 681 £

The steamer has a 30 horse engine with which she averages $4\frac{1}{2}$ knots, which she would do with ease, as she will encounter no head sea, a great part of the voyage will be in perfectly smooth water, and there will be very little head wind. She takes in at Madras coal to work her to Penang, 1,300 miles, and also to work her part of the way back, viz. 1,000 miles, in all 2,300 miles at 100 miles for $2\frac{1}{4}$ tons, making 53 tons. At Penang she deposits coal for 1,000 miles, taking in wood both there and at Singapoor and Malacca if necessary, for the Straits and also for the first 300 miles out of Penang towards Madras. The wood is taken on deck, and does not interfere with the tonnage.

Tonnage taken up by fuel and engine.

	Tons
From Madras; coal	53
Engine	20
	73
Towards Madras; coal	23
Engine	20
	43
Average ...tons	58
Deduct on account of tonnage saved in stowage of sails and stores	40
Net loss	18 tons
Tonnage of vessel	400
Available for freight	382 tons

As she would perform the voyage of 1,660 miles in 15 days, and allowing 10 for loading and discharging, she would in 90 days perform 3½ voyages, and allowing her to carry 360 tons each time.

Receipts.	£
360 tons of freight at 20 Rupees	720
Add profit on 2 passengers each trip	40
Receipts	760
Or for 3½ voyages	2660
Total receipts in 3 months	2660
Deduct expences	680
Net profits.	1980
Or per annum	7920

Which upon an outlay of 5200 £ is 130 per cent per annum.

The above remarks and calculations refer chiefly to a vessel worked with a very small power of engine, viz. 1 horse to 13 tons, in a vessel of 380 tons; it should now be considered what would be the effect of working with rather a higher power, though still one far short of that of the present passenger steamers.

STEAMER OF 380 TONS, WITH A 50 HORSE ENGINE.

COST.

	£
Hull	3600
50 horse engine	2000
Anchors and cables	200
Masts and sails (3 lugs)	200
Total costs	£6000

EXPENCES.

Insurance at 4½ per cent	270
Commander	360
Officer	120
1st Engineer	300
2nd do.	120
Armourer	120
Carpenter	48
4 Sucunnies	120
1 Syrang, 1 tindal, 10 lascars	168
6 Stokers	72
Butler and boy	24
Victualling 19 persons	24
Hired labourer in port	100
Repairing hull 2 per cent	72
Sundries, paint, &c.	50
Replacing hull 3 per cent	108
do. engine 9 per cent	180
Repairs of do. 5 per cent	100
Oil	20
	2376

Coal 26,500 miles at 132 miles per day or 240 days, in 19½

months, 870 tons, or 500 tons per annum at 16 S..........	400
Total cost per annum	2776 £

But as the sailing vessel takes 303 days to run that distance, while the steamer would take only 204, there would be 99 days saved out of the 23 months occupied by the former in her voyages; and while the former run 13,800 miles in the year, the latter would run 16,200 in that time; hence

	£
Proportional expence of steaming 13,800 miles...............	2360
Expence of sailing do. as before....................	2151
Do. of steaming above sailing.......	210

That is; the expence of working a vessel of 380 tons, with a steam power of one horse to $7\frac{1}{2}$ tons, would exceed that of sailing the same distance, or of steaming with a power of 1 horse to 13 tons, by £210 in 13,800 miles or by about $\frac{1}{11}$th.

Thus it appears that there is a certain speed at which steam vessels can be worked as cheaply as sailing vessels, but at a little higher speed, the steam power is more expensive.

The loss of freight in consequence of the space occupied by the coals and engine, must next be calculated.

	Tons
Coal for 2,400 miles as before, being 18 days at $4\frac{1}{4}$ tons per day.	76
Engine..	30
Total tons....................................	106
Deduct as before on account of saving in ship's stores	40
Loss of tonnage.......................	66
But as the sailing vessel would be deficient of freight on an average at least 30 tons, the actual loss of freight would be....................................	36
	or $\frac{1}{11}$

	£
Allowing for this, the cost of conveying 350 tons of freight in the steamer would be	2600
And in the sailing vessel..................................	2150

Expence of steaming at this speed above that of sailing...... £450

or $\frac{1}{5}$

In the above calculation, the steamer is supposed to average 132 miles per day, or $5\frac{1}{2}$ knots per hour. The speed of a vessel of 380 tons, with a 50 horse engine in smooth water, would be about 6 knots, 4 against a strong head wind and sea, and 7 with a fair wind and following sea (without masts and sails) her average would be at least $5\frac{1}{2}$ knots. This is exactly half as much again as the average of the above fast sailing vessel. According to this the voyages of the steamer, would be performed in two-thirds of the time required by the sailing vessel, but in reality they would probably take considerably less than that.

Thus it appears, that to work a vessel with such a power of steam as would ensure the voyages being performed in two-thirds of the time of a sailing vessel, it would cost one-fifth more; and there can scarcely be a doubt that the other advantages of steam, would far more than compensate for this increase of expence; or we come to the conclusion;

That it would answer as well to work a vessel by steam at an average rate of $5\frac{1}{2}$ knots, as by sails at $3\frac{3}{4}$ knots, measuring the distances on the nearest line from port to port, supposing that the average length of her voyages without taking in coal, did not exceed 2,400 miles, or that they varied from 1,000 to 4,000 miles, and hence that by the use of steam without any masts or sails, commerce might be carried on in most parts of the world at a speed exceeding by one-half that ordinarily attained at present by sailing vessels, without any increase of expence, and with much greater safety.

If a higher speed than this is required, it must evidently be purchased at a rapidly increasing cost, though this might answer in particular lines of trade, and especially where there was a considerable portion of passengers. And it is evident, that were this system extensively introduced, the carriage of passengers would form a much more considerable item of traffic; for the safety, certainty, comfort and speed of this mode, would increase the number of travellers by sea probably four-fold. The loss of time and uncertainty of passages in sailing vessels, besides their discomforts, make it almost impracticable for men much occupied, to move from one port to another, and they can only do it in very urgent cases. Powerful steamers working at ten knots, would of course be still more effectual, but first, they could not afford to carry passengers, but at a high rate of payment, and secondly, they are not likely at present to be established except on some main lines of intercourse. At the same time, such a

means of proceeding at a high speed along a few main lines, would greatly increase the number of passengers on the subordinate ones.

In all that has been said hitherto, it is supposed that the vessel has no standing masts or rigging and never uses sails. She has three small masts on board to be set up on the deck, with temporary rigging on which can be set three lug sails containing in all about $\frac{1}{3}$ of the full spread of canvass for a ship of her tonnage; these are merely kept in case of an accident which deprives the vessel of the use of her steam power.

Whether it would be advisable to use these sails occasionally when there was a steady leading wind is a separate question, which may now be considered.

The effect of a spread of canvass equal to $\frac{1}{3}$ of that of a ship under full sails, would be $\frac{5}{8}$ of her full speed, that is if under full sail she went 8 knots, with a leading wind, she would run 5 knots with $\frac{1}{3}$ of that quantity of canvass when the wind is on the beam, or quarter, but with the wind nearly aft, it would make a less difference than that. Further as she would be able to carry such low and small sails, without any weight of masts and yards above them, in a much heavier breeze than a sailing ship could carry full sail, the average difference of rate in the two cases would be much less than 5 to 8. There is a third point which would still further reduce this difference, viz. that as such a vessel would never have to beat or carry a heavy press of sail, she would of course be built on the model of a steamer, that is with a light draft of water, and great length, and consequently would with a leading wind require less sail than such as are built on the model of a sailing vessel, to give her the same speed. Allowing for these three considerations, the average speed of such a vessel with a leading wind could not be taken at less than $\frac{3}{4}$ of that of a full rigged ship. Hence if a sailing vessel averaged 7 knots while running down a trade, the speed of the steamer from her sails, and without using her engine, would be $5\frac{1}{4}$ knots and she might therefore put out her fires in such circumstances, without going below her average speed more than $\frac{1}{4}$ knot, if the vessel of 380 tons has a 50 horse engine; and with a gain of $\frac{3}{4}$ knot if she has only a 30 horse engine. Or she might use both steam and sails. In such cases, if she could run $5\frac{1}{4}$ knots by wind only, and $5\frac{1}{2}$ knots by her engine alone, she would have a speed of at least $7\frac{1}{2}$ knots, if she used both together. That is, such a vessel with a 50 horse engine would by the additional use of her sails run at least two knots above her average, and at least one knot more than she would go with her engine and a strong wind nearly aft and a following sea, but without sails. And such a vessel

with a 30 horse engine would run at least 7 knots an hour, or 2½ above her average, and one knot more than she would go under the most favourable circumstances without sails. Supposing then that such vessels used light sails occasionally, such as when running with a trade or monsoon on or abaft her beam, the calculation for her would be as follows;

STEAMER OF 380 TONS WITH 30 HORSE ENGINE.

	£
Expences as before	2050
Renewing and repairing sails per annum	60
	2110
Coal for steaming 15,800 miles at 120 miles per day, 132 days at 8 lbs. per horse power per hour, 340 tons at 16 S..	270
Total expence of steaming 15,800 miles	2380
Do. do. 13,800 miles	2080
Do. do. of sailing do	2150
Difference in favour of steaming	70 £

The speed of such a vessel would be 3 knots against a head sea and wind, 5 knots in smooth water and calm weather, and 7 using her sails with a trade of average strength; her average could not be less than 5 knots, while the sailing vessel averages only 3¾ knots; or the steamer would perform her voyages in three-fourths of the time of the sailing vessel. The sailing vessel was 303 days at sea out of 23 months, running a distance of 26,500 miles; the steamer would in this case accomplish that distance in 220 days, and consequently allowing the same time in port for both vessels, she would perform the same work in a little more than 20 months, or at the rate of 15,800 miles per annum; for this, allowance has been made in the above calculation.

Hence it appears that a vessel of 380 tons, worked by an engine of 30 horse power, fitted with movable masts and 3 lug sails to be used when there is a steady leading wind, would be worked cheaper at an average speed of 5 knots than a sailing vessel at 3¾ knots; that is, she would at less expence perform her voyages in ¾ of the time of a sailing vessel.

Or if such a vessel with a leading wind, made use of wind only, she

would on an average of voyages save about $\frac{1}{3}$ of her fuel, and hence she could run 6,000 miles with the same fuel, as she would require for 4,000 miles if she made no use of her sails, and as her speed in that case would be 3 against wind and sea, 5 in calms, and 5$\frac{1}{4}$ on an average, using her sails only ; her total average would be about 4$\frac{3}{4}$ miles or one-fourth more than that of a sailing vessel. That is

A vessel of 380 tons, with a 30 horse engine and fitted with moveable masts and light sails to be used in leading winds, without steaming at such times, cou'd be worked as cheaply as a sailing vessel, in voyages of from 1,000 to 7,000 miles without taking in coals, at a speed $\frac{1}{4}$ greater, or she would in her voyages save one day in 4.

The effect of occasional use of sails in such a vessel, with a 50 horse engine, may next be examined.

Steamer of 380 tons with engine of 50 horse power, using light sails occasionally.

	£
Expences as before, omitting coals	2376
Renewing sails, per annum	60
	£ 2436
Coal for 16,800 miles at 150 miles per day at 8 lbs. per horse power per hour, 480 tons at 16s	384
Total expense of steaming 16,800 miles	2820
Do. of do. 13,800	2320
Do. of sailing do.	2150
Excess of expense of steaming	170
	or $\frac{1}{12}$

The speed of this vessel would be 4 knots against a head wind and sea, 6 knots in smooth water and 7$\frac{1}{2}$ using her sails also ; taking her average at 6$\frac{1}{4}$ knots, she would perform her voyages in $\frac{2}{3}$ of the time of the sailing vessel. She would have performed the distance run by the latter, viz. 26,500 miles in 177 days, instead of 303, saving 4 months out of 23, the whole time occupied by the sailing vessel, and running in the year 16,800 miles. Allowing the steamer to lose as before calculated $\frac{1}{11}$ of her freight, the proportional expence for the same amount of tonnage would be

	£
Expence of working steamer as above	2320
Add for loss of tonnage $\frac{1}{11}$	220
	2540
Expence of sailing vessel	2150
Net increase of expence in steaming	£390
	or not $\frac{1}{5}$

Hence it appears that at an increased expence of less than $\frac{1}{5}$, a loss which there can be little doubt would be far more than compensated by the additional passengers, and other advantages hereafter enumerated, vessels could by this means be worked at a speed increased from $3\frac{3}{4}$ knots to $6\frac{1}{4}$ or in the proportion of 3 to 5, or a voyage which now takes 60 days would be performed in 36. That is

That a vessel of 380 tons, with a 50 horse engine, and using light sails in strong leading winds, would be worked as profitably at 150 miles a day, as a sailing vessel at 88 miles per day, or she would perform her voyages in $\frac{3}{5}$ of the time of a sailing vessel with far greater safety, certainty and comfort to all on board ; voyages ranging from 1000 to 4000 miles without taking in coal.

The above calculations are made from the actual expences and voyages of a fast sailing vessel, very profitably employed in the Indian seas. She can take in coal at Calcutta, Madras, Bombay, Singapoor and Sydney, and as she can obtain no freight on the return voyage from Sydney, she could bring back a full cargo of coal, and deposit part of what she does not use at P. Essington or King George's Sound, according as she returns by Torres Straits or C. Lewin, and part at Anjer, Singapoor or any convenient port, as may best suit her. Or she could have coal brought up by the numerous vessels sailing in ballast from Sydney for India, at a moderate cost. With a depôt of coal at P. Essington, King George's Sound and Anjer, she would never have to steam more than about 2000 miles without taking in coal, and the average distance without a fresh supply would not exceed 1800, while the calculations allow an average of 2400 miles.

It must also be remembered that the vessel used for comparison was undoubtedly much above an average sailer, so that the gain of speed and time by the use of steam would be certainly on an average greater than the calculation given.

We may now take a new case for examination, and that the comparison may be as complete as possible, the case of a vessel employed to carry coal, and without passengers, on as long a voyage as it can be necessary to carry coal, may be investigated. This must be considered an extreme case, for if it will answer to carry coal on a long voyage by a steamer, there can be no doubt that it will answer for any thing else.

Vessels are sent from Llanelly in Wales, to Bombay with coal for the steamers there. They are quickly loaded, and get the coal at about 7s. a ton, and receive from 35 to 40s. freight for it. A vessel making an average voyage fully loaded with coal, will perform the passage in 120 days, and complete her trip, so as to be ready to receive another cargo in about 5 months.

Expence of a sailing vessel of 600 tons, taking out 900 tons of coal.

	£
Cost of hull	6000
Fitting for sea	3800
Total cost	£9800

EXPENCES.

	£
Insurance at 4½ per cent	450
Commander	120
2 Officers	102
Carpenter 60£, boatswain 36£	96
	768
Steward 36, cook 36	72
30 men at 30£	900
Victualling 3 officers	135
Do. 34 hands at 1s. per day	612
Renewing sails	50
Rope	40
Spars, &c	30
Pitch, &c	25
Repairing hull 5 per cent	300
Replacing hull 3½ per cent	210
Port charges	60
	3202

Sundries	40
Total per annum	3242
Do. for 5 months	1350 £

Steamer of 600 tons.

	£
Hull	6000
Engine 30 H. P.	1200
Masts and sails	280
Anchors and cables	300
Total cost	£7780

EXPENCES.

	£
Commander and officers	222
Engineer	144
Armourer (capable of taking charge of engine)	84
4 Stokers	240
Carpenter	60
Steward and cook	72
10 men	300
Victualling 5 as officers	225
Do. 17 at 1s.	300
Renewing sails and ropes	30
Oil and pitch	20
Repairing hull $2\frac{1}{2}$ per cent	150
Replacing hull $3\frac{1}{2}$ per cent	210
	2057
	£
Repairing engine 5 per cent	60
Replacing do. 10 per cent	120
Insurance $3\frac{1}{2}$ per cent	273
Port charges	60

Sundries		40
Expences per annum		£2610
Do. for 4 months and 5 days		905 £
Coal for 95 days, at 8-lbs. per horse power per hour, 2½ tons per day at 7s...		83
Total expence for 640 tons 11,000 miles		988 £
	s.	d.
Do. do. per ton	£1 11	6
Expence by sailing vessel 900 tons		1350
Do. per ton	£1 10	0

That is the expence of steaming would exceed that of sailing by 1s. 6d. per ton carried, but 25 days would be saved in the voyages.

PROFITS ON SAILING.

Supposing the freight to be 2£ per ton.	£
Profit on 900 tons at 10s. (in 5 months)	450
Proportional profit in a year	1080
Which upon a capital of 9800£ is	11 per cent.

PROFITS ON STEAMING.

	£
640 tons at 8s. 6d. (in 4 months 5 days)...	272
Proportional profit per annum	782
Which upon 7780£ is	10 per cent.

That is the profits upon the voyage by the sailing vessel would be 11 per cent. and in the steamer only 10 per cent.

In the above estimate, the coal carried by the steamer is thus reckoned

	Tons
Total coals conveyed in sailing vessel....	900
Deduct coals consumed 240 tons, engine 20 tons.	260
Coal conveyed by steamer	640 tons

The sailing vessel in this case, with a full cargo of coal, is supposed to make her voyage in 120 days, and as the distance measured on the nearest line is 11,000 miles, this is, at the rate of 92 miles a day, or $3\frac{3}{4}$ knots per hour. The steamer is supposed to go $4\frac{1}{2}$ knots in smooth water, on an average against the wind 3, and 7 with a good breeze and steam together, averaging on the whole $4\frac{3}{4}$ knots, which would make her voyage 95 days. It is to be observed that the steamer is built with a light draft of water, and of great length like other steamers, and not like a sailing vessel, so that light sails would give her much greater speed than the same quantity set on an ordinary sailing vessel. Also that she consumes 240 tons in the course of her voyage, so that her cargo taking the average of the voyage is 120 tons less than that of the sailing vessel. In the course of her passage, she would not encounter a head wind on many days as she would of course choose her route, so as to avoid them as much as possible; for instance after crossing the line she would keep so near the West Coast of Africa as to avoid the steady S. E. trade.

But if upon estimating such a case as the above, there should be any thing like reason to believe that it might answer, how evident it must be, that for the first class of passenger ships to India it would certainly be in every respect the most eligible plan. Some trials are already making on the use of steam of small power in such vessels, and there cannot be a doubt that it will be a great advantage, but in applying it as at present to assist a full rigged vessel, the main advantages are lost, viz. safety, convenience and comfort. As long as ships carry masts, they must be exposed to many dangers which they would not otherwise encounter. By getting rid of the standing masts and rigging altogether, the vessel is made almost independent of the weather, she can scarcely ever receive any damage in the open sea, and even on a lee shore, a very moderate power of engine would enable her to keep an offing. She would be built on a steamer model with which she would require a much more moderate power of engine than the present vessels to give her the same speed; besides which, both from her greater length, and from her upper deck being unencumbered, she would have about twice as much accommodation for passengers as a sailing vessel of the same tonnage. Further, she would be always nearly upright, and as she would be mostly in those parts of the ocean, where she would find the lightest winds and smoothest water, she would seldom have much motion. When it is thus considered that such a vessel would have such decided advantages over any vessel with standing masts, in safety, comfort, convenience, speed and extent of accommodation, and it has been already shown how near she would

come to the latter in point of expence, there seems no room for doubt that there could be no comparison between the two, as passenger ships. In such a vessel the passengers would scarcely be disturbed one night in a whole voyage.

But perhaps the most important application of this system at present would be to the emigration to New Holland. Those noble colonies afford an unlimited field for the employment of all classes of people, and the grand desideratum above all others for them, is the means of a safe, convenient, rapid and cheap transport of emigrants. At present the governments of the different colonies allow 20£ for every adult male, and a proportional sum for women and children. A vessel of 600 tons, new measurement is allowed to carry about 240 persons. Such a vessel will ordinarily draw about 17½ feet of water, with a length of 125 feet. A vessel of the same tonnage, built as a steamer, need not draw more than 11½ feet, perhaps less; and with the same beam as a sailing vessel of the same measurement, she would have a length of 180 feet, which would give her full half as much room again for passengers' accommodation, and as her upper deck would be unencumbered, and might therefore be occupied for ⅔ of her length by passengers, her accommodations altogether would be fully double those of a sailing vessel of the same tonnage, or she could carry 480 persons of all ages. A vessel of that class is at present chartered for about 2500£, which gives about 10£ a head for each individual emigrant exclusive of their food; this costs, it is said about 3£ 10s. making the total actual expense of transport probably about 15£ a head, including sundry expences; the government allows at present 20£ for men, and the profit may be on an average 2£ a head upon all ages. The question is at what cost a vessel of this tonnage worked by steam could be taken out to New Holland, in comparison of that of a sailing vessel. An average passage at present is about 110 days, and the distance measured on the nearest line is 12,800 miles from Plymouth to Sydney, giving an average of 107 miles per day or 4½ knots per hour. A 600 ton steamer with an engine of 40 horse power would run 5½ knots in smooth water, 3½ on an average head to wind, and 8 on an average with steam and light sails while in the strong westerly winds between the Cape and Bass' Straits (about half of the voyage); giving a total average of about 5½ knots an hour, and a length of 90 days for the passage, of which the fires may be out for at least 20 days, when the westerly winds are very strong, leaving 70 days of steaming to be provided for. Her cargo at starting would then be;

	Tons
75 days coal at 3½ tons per day	260
Water and provisions for 360 persons	180
Engine and sundries	50
Baggage, &c................	90
Total weight on board ....tons	580

She would of course become lighter every day, and towards the end of the voyage would have a considerably increased speed on that account, while it would not be at all necessary to have any great weight in a vessel not carrying any sails on a wind, and only very light ones when the wind was fair. Her expences would be ;

	£
Annual expences as before given, excepting coal............	2610
Do. for 110 days.............	803 £
260 tons of coal taken in, in London at 18	231
Total expences of voyage....	1040
Which for 360 persons would be per head	3 £

A sailing vessel of that tonnage would carry 240 persons, and occupy 4½ months in all on the voyage.

	£
Annual expences of a 600 ton ship as before.......	3240
Do. for 4½ months.....................	1215
or per head.....................................	5 £

Hence it appears that the cost would be 5£ a head in a sailing vessel and only 3£ a head in the steamer, while the voyage would be shortened 20 days, besides all the advantages of safety, comfort and certainty already enumerated, thus giving the advantage to the steamer in a great degree, and in every respect.

The cost of provisions would also thus be reduced nearly one-fifth, causing a further saving per head of 12s. The expence of ship and feeding, would then be 6£ a head, or including sundries probably not more than 8£ a head on an average. The expence in larger vessels would, probably be still less, and there is therefore a fair prospect that the colonies might get emigrants brought out at ⅔ of what they at present pay for them ; which is further shown thus ;

	£
Actual expences of sailing vessel........	1215
Rate at which it can be chartered............	2500
Actual expences of steamer................	1040
Proportional rate of charter....................	2100

240 persons in former gives per head........................	10 £	
340 do. in latter do. do.	6 £	
Saving..........	4 £	
Add do. food..	0	12
Total saving.....	4	12

which, taking men and women and children together, is about ½ of what the colonies now pay for them. This too allows a profit of 1060£ upon the voyage which is probably too much, as such vessels would certainly have the choice of freight and passengers for the home voyage. They would generally go home by the Cape of Good Hope, instead of Cape Horn, which would be a much preferable passage. For half the year, they might go by C. Lewin, and the other half through Torres Straits. A vessel went home by the latter route this year, and there seems little room for doubt, that shortly it will be preferred by all vessels, as being shorter, and a fair weather-voyage almost throughout. The dread of Torres Straits for sailing vessels has now nearly passed away, and there is still less objection to a steamer making that passage than a sailing vessel. Such vessels might also be used to meet the Indian steamers at Batavia or Trincomalee. The former would take them but little out of their way, on their passage home from Sydney by Torres Straits. There is a difficulty to be got over in respect of carrying the number of emigrants proposed, as being greater than that at present allowed by law that is, if the vessel is measured for emigrants by the same rule as for tonnage, viz. taking the depth into the calculation, but if they are measured as transports are measured for troops, viz. by the breadth and length only, there would be no difficulty in the matter. If, however, the number at present allowed is in proportion to the tonnage, it would be necessary to get an act passed for this new class of vessels, and as

they would be in every respect so far preferable for conveying emigrants, there is little doubt that the act required could be obtained.

It may yet be worth while considering how far this principle might be applicable to men-of-war. The steam frigates already built, have as usual in commercial vessels, engines of great power, but they consequently are subject to the serious drawback of carrying fuel for 20 or 30 days only, and must consequently be fully rigged, which both obstructs them when steaming to windward, and encumbers their decks. Steamers of moderate power on the contrary, would have the disadvantage of being less fast, but they would carry coal for several months, and would have the whole battery on the upper deck, free from all encumbrance. It seems probable that vessels of the three classes acting together, would form the most effective squadron, that is, if it consisted of a small number of steamers of full power ; three or four times that number of steamers of moderate power, and a few sailing vessels. As men-of-war probably do not make their voyages on an average at a greater speed than 5 knots, measured on the nearest line from port to port, the proposed vessels need not have engines of greater power than would be sufficient to give them that average rate with the help of movable masts and light sails—to be used in running in a trade or monsoon, and consequently they might be perhaps one-fourth of the power of those in the present steam frigates.

A 52 gun ship, supposing her tonnage to be 2,200 tons, would require an engine of about 100 horse power to propel her at 5½ knots in smooth water, which would consume 9 tons of fuel per day, and consequently with 900 tons, she could steam at her full speed on an average, 13,000 miles, and supposing that in the course of her voyages she sailed without using her engines 4,000 miles, she would then be provided for a distance of 17,000 miles, with that quantity of fuel, which is perhaps as much as men-of-war on an average sail in 12 months, measuring the distances on the nearest line from port to port. But it would be seldom if ever necessary for such a ship to be provided with fuel for 17000 miles, as coal is now to be obtained in Calcutta and Sydney, as well as in England and North America. These vessels in action would possess almost all the advantages of steamers of full power, as they could choose their position independent of the wind, and all hands would be at liberty for the guns, while from their carrying lighter engines, they could bear heavier batteries.

Upon this review of this very important subject, there appears, to say the least, abundant reason to believe that the use of steam of moderate power in vessels of all classes is well worthy of the attention of the

merchant, the naval officer, the statesman, and the philanthropist, as well as of the iron master, the engine-maker and the coal proprietor.

Some of its advantages may be thus generally stated;

1st.—Such a vessel would be far preferable for passengers; the time of her voyages would be only $\frac{4}{5}$ of that of sailing vessels, and it would be almost certain to a day; her upper deck would be quite clear, leaving much more room for accommodations; she would be much cooler, for there would always be a current of air through her; instead of seeking those parts of the ocean where there is most wind and consequently most sea, she would always rather choose those where there were calms and smooth water; she would be so little affected by the weather that it would very rarely happen that there would be any cause of alarm from it. She would be liable to accidents from steam, but many years of experience have now proved beyond a doubt that the danger in steamers is extremely small, the number of accidents compared with the number of voyages made, being much fewer than in similar voyages in sailing vessels. On these accounts she would be sure of a much larger proportion of passengers, and at the same time be capable of carrying a greater number than a sailing vessel, so that while she would carry as much freight, she would carry more passengers and consequently be more profitable.

2d.—On account of the greater speed and certainty she would also be preferable for freight and would be sure of the most valuable freight in the market, and also she would be more generally filled than a sailing vessel.

3d.—When leaving one port for another so situated that owing to the monsoon or trade, a sailing vessel would have to make a vast circuit, she would run direct or nearly so, excepting in one or two peculiar cases, such as leaving Bombay for the westward in the strength of the south-west monsoon, but as sailing vessels could not then attempt such a voyage, she would still be on a par with them even in such a case.

4th.—There would not be half the objection to her touching at intermediate ports as to sailing vessels which are always liable to be delayed by calms and variable winds when they are going in or out of port, whereas a steamer would lose no more time by it, than was necessary to steam such a distance out of her course.

5th.—The charge of such a vessel to both her commander and her officers would be incomparably easier and more pleasant than that of a sailing vessel; nothing less than a gale of wind would make it necessary for them to undergo exposure or fatigue; the commander especi-

ally would scarcely have a cause of a moment's anxiety in a whole voyage, and even in approaching land they would be almost as much at ease as in the open sea.

6th.—From the absence of all strain from the masts and sails, the vessel would scarcely ever require repair, or be in danger of leaking, and it must consequently be very seldom that she would require to be docked; for she would never be exposed to the trial which the passenger steamers worked at high speeds undergo, in being forced with great power of steam directly through the heaviest seas at 5 or 6 knots an hour.

7th.—Such a vessel would often obtain a freight of unusual value, on account of her speed and certainty, which might make it worth a merchant's while in many cases to charter her above the ordinary rate of freight. And, indeed, it is not improbable that such a vessel would regularly command a higher freight than sailing vessels.

8th.—She would frequently obtain employment as a tug or to assist a vessel in distress, which she could do where sailing vessels would be of no use, and so become entitled to salvage.

9th.—As the time she would require for any voyage would be almost certain to a day, she would often obtain freight or charter for a short trip, while waiting for cargo for a longer one; which a sailing vessel could not venture to do, from the uncertainty of the time of her absence from port. The steamer would in this way be incomparably more handy than a sailing vessel, and would in fact probably do half as much again in the same time. For in a great prop ortion of mercantile transactions certainty as to time must cause a preference.

10th.—In the case of emigrant ships, which generally have more spare room in their hold than would carry the engine and fuel; the speed, the unencumbered state of the upper deck, the certainty as to time, the small number of the crew, the vessel being almost always upright, these things must give her a prodigious advantage over sailing vessels.

11th.—The same reasons as mentioned in the last paragraph, would always secure the preference of such vessels for the conveyance of troops, and indeed those advantages would be so considerable as probably to secure a higher rate of charter as transports.

12th—Is it too much to suppose that if commerce were generally carried on in these vessels, the loss of life and property would be reduced to one-fourth of what it is at present. Of vessels lost at present perhaps nine-tenths are lost upon rocks or on the coast, but of all such how very few there are that would not have been able to keep clear of the land, if they had had a moderate power of steam on board, instead of being de-

pendent upon sails ; and of those that are lost in the open sea, almost the whole are lost through their masts, from which cause of danger, the steamers would be freed.

13th.—All possible improvements in chronometers, and the means of finding the latitude and longitude, would have an effect upon navigation not worth mentioning in comparison of what would be effected by the general use of steam, for there would then be no necessity whatever for ascertaining a vessel's position to a nicety ; in approaching the land it would be a matter of little consequence to her whether the weather was thick or clear, or whether she made the land to windward, or to leeward of her port ; and when she did run into any danger she could just as easily run out of it again ; not that it is impossible for a steamer to be lost, but in nine cases out of ten, a position which renders the loss of a sailing vessel inevitable, would not in the least endanger a vessel without masts but with a moderate steam power.

14th.—In the case of war steamers, a small squadron could carry a large body of troops, as the length of the voyage would be almost certain, and they could not only appear at any moment upon any point of an enemy's coast, but they might proceed direct up any navigable river, and land the whole force, complete and fresh, in the heart of the country, and also proceed up the rivers in support of them after they were landed.

15th.—It is by no means the least important feature in this plan, that those vessels would draw little more than two-thirds of the water, that vessels intended to carry heavy masts and to work to windward must draw, so that they would enter ports, rivers and channels, where at present vessels of two-thirds of their burthen could scarcely enter. Thus many harbours and rivers at present almost useless as ports, would become equal in value to those now containing half as much water again.

It may here be remarked, that in all the above calculations of expence the commander and officers are supposed to be unacquainted with the steam engine, but it is evident that if the system was introduced, they would soon be men as well acquainted with the management of an engine as they are at present with that of the sails, for the former would be as much their business in steamers without sails, as the latter is at present. This would of course reduce the expence materially.

In conclusion it must be remembered that all the calculations in this paper are made upon the present state of the marine steam engine. Taking into consideration that every year adds some improvements, is it too much to expect that by the further reduction in the quantity of fuel required, the advantages may be so decidedly in favour of steam, that sailing vessels will in time, be as few in proportion as steamers are now.

For instance it is well known that the mine engines in Cornwall, are some of them worked with less than 2-lbs. of coal per horse power per hour, which is one-third of the quantity consumed in the best engines at present afloat, and a quarter of what is allowed in the above calculations; and again with respect to the weight of boilers, those used on railroads and making steam sufficient for a 50 horse low pressure engine, weigh only about 6 tons. From what has been thus already accomplished in other branches of steam power, we may fairly conclude that much will yet be done in engines used for marine purposes.

The principal difficulty to be overcome in the introduction of such a new system as this in navigation would be the persuading men to trust themselves at sea without standing masts ; it is well known how difficult it is to lay aside any thing in which men have been accustomed to trust for ages ; the use of masts in the powerful coasting steamers, after so many years have shown that they are of little or no use, is a case in point. A remarkable instance was also seen in the case of the introduction of chain cables ; ships were not trusted at sea without a hempen cable, till very long after they had ceased to be used. But the removal of standing masts is an *essential feature* in the proposed plan for neither can very low steam power be used, if vessels are to encounter the resistance of the wind to masts and rigging, nor can a masted vessel be worked with the small crew proposed.

If a sufficient crew is to be carried to work sails, it alters the whole case, and such an arrangement is not the one proposed. The question is, whether it will not answer to work a vessel by low steam power *instead* of by the winds.

October 1840.

III.—*On the Separation of the Pomegranate as a distinct Natural Order from Myrtaceæ.—By* Robert Wight, m. d., &c.

The most eminent botanists of the present day being divided in opinion as to the propriety or otherwise of separating the Pomegranate as a distinct natural order from Myrtaceæ, I have recently been induced to examine this question, bringing to my aid the lights thrown on carpellary arrangement by my recent investigations of Cucurbitaceæ.

The result of this examination has led me to the conviction, not only that Granateæ is a distinct order, but that the pomegranate, if my views are correct, is, so far as our information yet extends, the most remarkable fruit in the system of plants. But, without further preface, I shall at once proceed with the subject, introducing it by presenting a series of extracts from the leading disputants on either side. The whole controversy turns on a simple question of fact, namely, what is the structure of the ovary and fruit of Punica? To these points therefore I shall, to save room, limit my extracts. The first of these, taking them in chronological order, is from Mr. D. Don's paper, Edin. New Philosop. Journal, for July 1826. The second is from DeCandolle's Prod. 3. p. 3. The third is from Dr. Lindley's Natural System of Botany, ed. 1st, page 64, and repeated in the second edition. The last is from Mr. Arnott's article Botany, Encycl. Brit. ed. 7, page 110, under Myrtaceæ. These extracts, by placing the question before the reader in all its bearings, will enable him at once to judge, how far I have succeeded in setting the question at rest.

" *Bacca* pomiformis, limbo tubulosa dentato calycino, nunc contracto, coronata: *cortex* crassissimus, extûs cuticulâ lævi rubicundâ punctatâ lucidâ vestitus, intus spongioso-carnosus, albus, dein, maturâ baccâ, fissurâ irregulariter rumpens. *Placenta* cortici baccæ substantiâ simillima, at magis carnosa et succulenta-baccam omnino replens, in loculis numerosis polyspermis inæqualibus reticulatim atque interrupte excavata. *Dissepimenta vera* nulla: *spuria* tamen adsunt, quæ e substantiâ placentæ orta, valdè sunt fragilia, et crassitie variâ. Don (l c.)

" The real structure of the fruit of the pomegranate appears to have been overlooked by all authors, I have consulted on the subject, and even the distinguished Gærtner has fallen into error both in his description and figure. It is in reality a fleshy receptacle, formed by the tube of the calyx into a unilocular berry, filled with a spongy placenta, which is hollowed out into a number of irregular cells, in which the seeds are placed ; the dissepiments being nothing more than thin portions of the placenta. If we could conceive the fruit of *Rosa* to be filled up with an interrupted pulpy matter, it would be exactly of the same structure as the pomegranate." Don (l.c.)

" Fructus magnus, sphæricus, calycis limbo subtubulosa coronatus, ejusdem tubo corticatus, indehiscens, diaphragmate horizontali inæqualiter bicameratus ; camerâ superiore 5-9-loculari, camerâ inferiore minore 3-loculari, septis utriusque membranaceis loculos separantibus ; placentæ cameræ superioris carnosæ a parietibus ad centrum

tendentes, in inferiore processus irregulares ab ipso fundo" D. C. (l.c.)

" The fruit of the pomegranate is described by Gærtner and DeCandolle, as being divided into two unequal divisions by a horizontal diaphragm, the upper half of which consists of from 5 to 9 cells, and the lower of 3 ; the cells of both being separated by membranous dissepiments ; the placenta of the upper half proceeding from the back to the centre, and of the lower irregularly from their bottom ; and by Mr. Don as a fleshy receptacle formed by the tube of the calyx into a unilocular berry, filled with a spongy placenta, which is hollowed out into a number of irregular cells. In fact, if a pomegranate is examined, it will be found to agree more or less perfectly with both these descriptions. But it is clear that a fruit as thus described is at variance with all the known laws upon which compound fruits are formed. Nothing, however, is more common than that the primitive construction of fruits is obscured by the additions, or suppressions, or alterations, which its parts undergo during their progress to maturity. Hence it is always desirable to obtain a clear idea of the structure of the ovarium of all fruits which do not obviously agree with the ordinary laws of carpological composition. Now, a section of the ovarium of the pomegranate in various directions, if made about the time of the expansion of the flowers before impregnation takes place, shews that it is in fact composed of two rows of carpella, of which three or four surround the axis, and are placed in the bottom of the tube of the calyx, and a number, varying from five to ten, surround these, and adhere to the upper part of the tube of the calyx. The placentæ of these carpella contract an irregular kind of adhesion with the back and front of their cells, and thus give the position ultimately acquired by the seeds that anomalous appearance which it assumes in the ripe fruit. If this view of the structure of the pomegranate be correct, its peculiarity consists in this, that, in an order the carpella of which occupy but a single row around the axis, it possesses carpella in two rows, the one placed above the other, in consequence of the contraction of the tube of the calyx, from which they arise. Now, there are many instances of a similar anomaly among genera of the same order, and they exist even among species of the same genus. Examples of the latter are, Nicotiana multivalvis and Nolana paradoxa, and of the former Malope among Malvaceæ ; polycarpous Ranunculaceæ as compared with Nigella and polycarpous Rasaceæ as compared with Spiræa. In Prunus I have seen a monstrous flower producing a number of carpella around the central one, and also, in consequence of the situation, upon the calyx above it ; and, finally, in the *Revue Encyclopédi que* (43.762.) a perma-

nent variety of the apple is described, which is exactly to *Pomeæ* what Punica is to *Myrtaceæ*. This plant has regularly 14 styles and 14 cells, arranged in two horizontal parallel planes, namely, 5 in the middle, and 9 on the outside, smaller and nearer the top; a circumstance which is evidently to be explained by the presence of an outer series of carpella, and not upon the extravagant hypothesis of M. Tillette de Clermont, who fancies that it is due to the cohesion of 3 flowers." Lindley (l.c)

"To the Myrteæ we, with Mr. Lindley, unite the Granateæ, because *Punica* or the pomegranate only differs by having its two verticels of carpels developed instead of one, and perhaps in a truly wild state the upper or adventitious one may occasionally disappear. The inner series (or those at the bottom of the fruit) have their placentæ in the axis; but the outer series, forced to the top of the fruit by the contraction of the mouth of the tube of the calyx, having their placentæ in the ovary at the back of the inner carpels, exhibit them in the ripe fruit in a horizontal position on the upper surface of the lower cells." Arnott (l.c.) et Prod. Fl. Peninsulæ, 1, page 327.

Premising that the whole controversy turns on these questions,—1st what is the true structure of a pomegranate? and 2d, whether the difference between it and Myrtus is sufficient to separate these genera as distinct orders?—I shall now proceed to examine these conflicting statements, and endeavour to ascertain on which side the balance preponderates, and whether, indeed, there is not room for an explanation different from any of those yet proposed.

Mr. Don's description of this fruit, on the strength of which he first proposed to remove this genus from Myrtaceæ, the order with which it was previously associated, as a distinct family, appears to me most unphilosophical and altogether untenable. He, as I understand, considers the fruit a one-celled receptacle, the centre of which is filled with a spongy placenta, round the surface of which there are a number of irregular cells occupied by clusters of ovules, but he does not tell us how the central placenta got there, neither does he account for the ovules being attached to the parietes of the cell, and not to the central placenta. His whole description in fact proves that it had been drawn up from inadequate examination, and that he, at the very time he is accusing all authors of overlooking the real structure of the fruit, totally misapprehends it himself, as we shall by and by see.

DeCandolle gives a more correct description of it when he says, that it consists of two chambers, the under 3-celled, the upper from 5 to 9-

celled, with the placentas of the upper cells reaching from the parietes to the centre, while those of the lower division proceed irregularly from the bottom of the fruit. He does not, however, assign this peculiar structure as his principal reason for viewing the order as distinct from Myrtaceæ, but has recourse to others, in my estimation, of minor importance.

Lindley conceives that there are two rows of carpels, three or four of which surround the axis at the bottom, while the remainder surround these, and, occupying the upper part of the fruit, adhere to that part of the tube of the calyx. The placentas of these upper carpels, he conceives, contract an irregular kind of adhesion with the back and front of their cells. The meaning of this is far from being clear to me, but if it means that he considers the placentas of the upper as well as the lower row to proceed from the axis towards the circumference, to which last they contract accidental adhesions, then he takes an erroneous view, and if the examples quoted in illustration support this view, they are not in point as regards the structure of Punica.

Mr. Arnott, like Lindley, views the fruit as consisting of two rows of carpels, an outer and inner, the former of which he thinks may be adventitious. To understand his theory, we must first suppose the tube of the calyx spread out as a flat surface and covered with two circles of carpels, the inner next the axis, and the other occupying a larger circle beyond, that the margin of the calyx then contracts so as to turn the outer series over the inner. According to this supposition, the attachment or base of the placentas of the outer series should be in the circumference, and the apex in the centre, while that of the inner should be in the opposite direction, that is, have the base in the centre and the apex towards the circumference; an explanation which is in accordance with what we find, except in so far as it does not account for the horizontal partition between the two series: nor can I exactly understand on what ground we are warranted in assuming that the outer series is adventitious and the result of cultivation, as it has every where been found so constant in all circumstances. But be that as it may, this theory certainly accounts for the crossing of the placentas in the two rows which we so invariably find, whether correctly or not, cannot be determined, until we get fruit with a single row of carpels, which has not yet been found.

These explanations, which I venture to propose, of rather obscure descriptions, did not occur to myself until after I had formed a new theory of my own, the result of a very careful examination of the ovary in all stages from the earliest, up to the period of impregnation. At these early stages, when the whole flower had not yet attained half an inch in

length, probably a fortnight or more before expansion, I invariably find two rows of carpels, one inferior, of 4 or 5, and one superior of 5, 6 or more. In the lower series the placentas are ranged round the axis, with their base in the centre, and the apex, which is free, towards the circumference. In the upper, the attachment, or base of the placentas, is in the circumference, and the apex, also at first free, directed towards the centre. Between the two rows a diaphragm is always interposed. The apex of the upper placentas is, occasionally, afterwards prolonged and contracts adhesions to the axis.

In the accompanying figures I have attempted to represent these views. As the fruit advances in size considerable derangement of this structure progressively occurs, which is apt to mask and confuse the appearances now described.

Having previously ascertained the occasional existence of inversion in the position of carpels, my first idea was, that such an inversion took place in the upper row. This view, which, equally with the preceding, accounts for the crossing of the placentas, I feel inclined to adhere to, though I confess not without some hesitation, because it implies a complexity of arrangement rarely met with in the inimitably simple and beautiful operations of nature; but I think it as difficult to imagine the nearly equally complex and inconceivable operation of the folding in of one set of carpels over the other, which Drs. Lindley and Arnott's explanation demands: while my explanation has the advantage of at the same time accounting for the double chamber which the ovary presents from its earliest stages, and renders unnecessary the doctrine of an adventitious verticel of carpels, which for the present is mere assumption.

With these explanations, I leave the question of structure to consider the one pending on its determination, viz. whether or not Granateæ ought to be preserved as a distinct order or be re-united to Myrtaceæ?

On this point, so far as the unvarying evidence derived from cultivated plants is entitled to carry weight on a disputed point—and which I presume it must do until we find that evidence invalidated by the examination of others growing in a truly wild state—we must unquestionably, I conceive, adopt the views of those who urge the separation, because the complex structure, above described, being constant here and unknown among the true Myrtaceæ, we have no right, in the total absence of direct confirmatory evidence, to assume, that a part is adventitious, merely because it is at variance with our ideas of what should be, especially while we have, in addition, difference of habit in the formation of

the seed, and their pulpy envelope, in further confirmation of the correctness of these views.

In coming to this conclusion, I do so, mainly on the evidence I have myself adduced : attaching no value to the opinion of Mr. Don, which, being founded, according to his own showing, on most erroneous view of the structure of the fruit, does not merit much consideration.

To the views of DeCandolle more importance must necessarily be attached, as the reasons he assigns are more satisfactory, though I do not think he has attached sufficient value to the very peculiar " economy of the fruit," while he has given too much to others of much less note, such as the want of pellucid dots, the absence of the marginal nerve of the leaves, and the pulpy covering of the seed ; thereby throwing into the shade the true essential character of the order, which unquestionably lies in the double row of carpels, with the upper placentas parietal and crossing the lower axillary ones, which, if I have rightly accounted for, constitute this a truly curious and unique fruit ; and which, whether or not my theory of its construction be correct, is yet so very different from that of every true Myrtacea, as to leave no doubt of its forming the type of a distinct order.

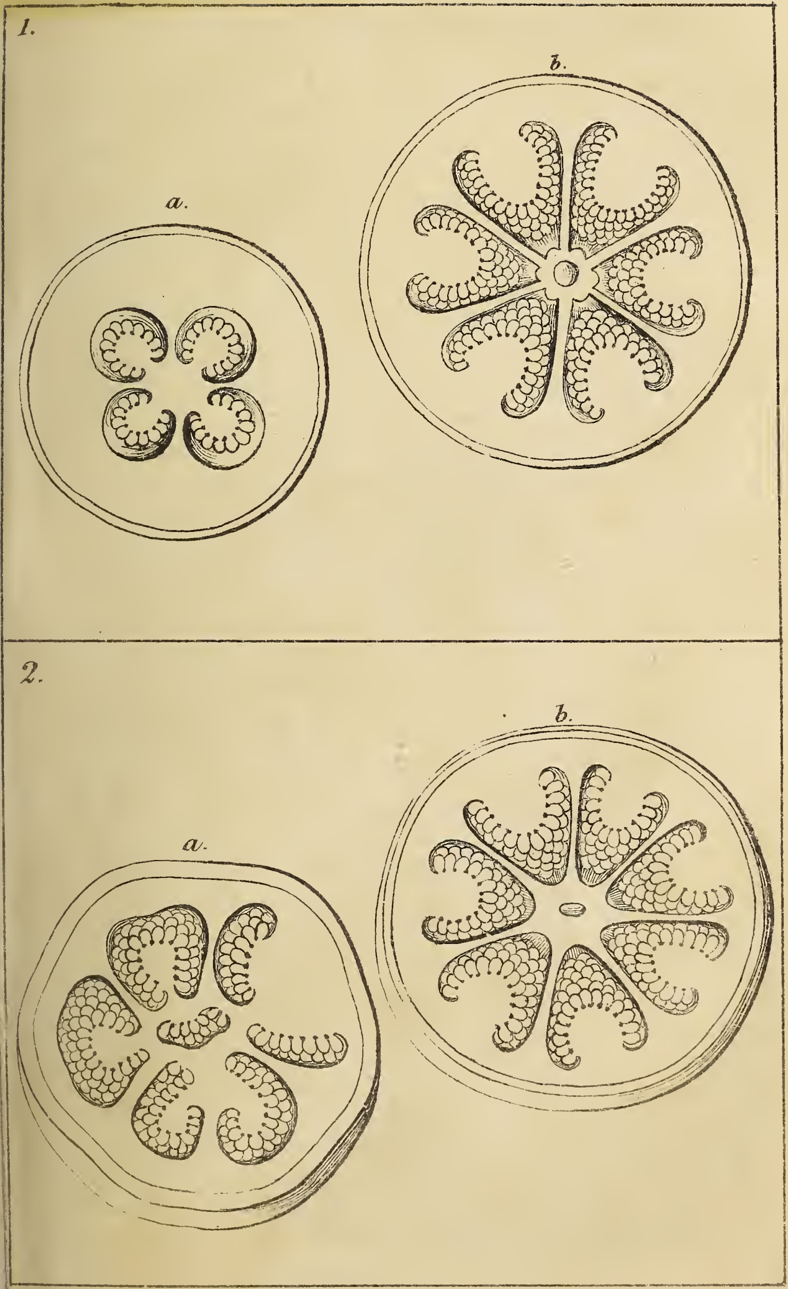
EXPLANATION OF PLATE.

1.—a. Section showing the lower series of carpels in the ovary of the Pomegranate many days before the expansion of the flower.

b. Section showing the upper series of carpels. These two figures are taken from opposite sides of the same slice.

2.—a. Section showing the lower series of carpels in an ovary some days after the expansion of the flower. At this time considerable derangement has taken place apparently caused by the rapid expansion, in a confined space, of the ovules after impregnation.

b. Upper series in the same ovary, and, as in the former instance, taken from the opposite sides of the same slice. Here the derangement so obvious in the lower section has not taken place.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a.
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2.
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b.

BRITISH MUSEUM
NATURAL HISTORY

IV.—*On the Construction and use of Portable Barometers.—By Captain* J. Campbell, *Assistant Surveyor General.*

1.—From some cause, not yet properly investigated, barometers, as hitherto constructed for portability, generally become damaged on the voyage to this country, and even are liable to injury during transport on land in this climate. I consider it likely that the plan on which these instruments are constructed is faulty, and that the expansion of the mercury in those, the tubes of which are closed by a screw, is sufficient to cause the fracture of the tube. It is even probable, when carried in an inverted position, that the expansion of the mercury in the tube and the air in the cistern, which in this position will be of course in the bottom part of it, is sufficient to force out the mercury through the pores of the cover, and that the alternate expansion and contraction of this portion of air, according to the changes of temperature, may be sufficient to force out all the mercury in the cistern, or to leave so little in it, that, on setting up the instrument, there is not sufficient left to cover the aperture of the tube.

2. On examining a damaged mountain barometer, on "Newman's improved portable iron cistern" plan, I consider I have found some reason to suppose that the above remarks may be correct, and as the construction of the instrument is not generally known, I append the following description.

3. The cistern of this instrument is formed of a cylinder of iron $2\frac{1}{2}$ inches long and 1 inch and three-tenths in diameter. The cover of it is a close grained piece of box wood, cemented on to the tube and screwed tightly into the cistern. Through the pores of this piece of wood the air finds a passage to exert its pressure on the surface of the mercury; and, under considerable pressure, the mercury would probably also be forced through the pores. The bottom of the cistern is double, the lower part being about one-fifth of the capacity of the upper. This lower part turns on a centre, by which it is attached firmly to the other piece, and when turned to "not portable," as engraved on the brass case, two holes in each part coincide, so as to open a passage between the two divisions, and when turned to "portable" these passages are tightly closed. In constructing the instrument, the tube having been boiled, it is attached to the cistern by cement, the cistern is then filled full of mercury, and the bottom part is then turned to "portable", which closes the apertures of communication, and leaves the part of the cistern with which the tube is connected *perfectly* full of mercury. By a screw hole the mercury in the movable bottom is then allowed to run nearly all out, and,

the screw being replaced, the instrument is finished. The bottom part is then turned to " not portable," and the instrument is set upright. In this position, the air which was in the movable bottom of course passes up through the two apertures, and the mercury descends into the space the air had occupied, thus leaving a part of the upper cistern empty to allow of the descent of the mercury in the tube. The instrument is then compared with a standard barometer, and the scale adjusted so as to shew the proper height. The height of the column indicated at this time is called the " neutral point." When the instrument is prepared for transport, it is first inverted, by which the mercury again fills the vacuum in the top of the tube, and also fills completely the upper part of the cistern, and the bottom being turned to " portable" all motion of the mercury in the tube is prevented. But the consequence is, that no allowance is made for the expansion of the mercury in the tube, and supposing the instrument packed in London at the temperature of 32°, and that on the voyage it was exposed to a temperature of 140 (which is quite probable), the expansion of the mercury in the tube 32 inches long would amount to more than three-tenths of an inch, and the wooden cover of the cistern being nearly 50 times larger than the tube, this expansion of the mercury would act with an *irresistible* force, multiplied 50 times, to force out the cover, or the mercury into its pores. There can be little doubt that the cover, after being exposed to this enormous pressure, would become loose, after which the expansion of the small quantity of air which would get into the cistern after the instrument was exposed to cold again, would be able to force out more mercury from the cistern, an effect which would go on increasing until the instrument was quite destroyed : or if set upright with the movable bottom part turned to " portable," the weight of the mercury in the top of the tube, would exert a pressure increasing as the barometrical pressure at the place decreased, and most likely quite enough to force out more mercury from the loosened joints. Another defect in the instrument arises from the cover of the cistern being made of wood. In the instrument examined, this has shrunk so much, that it is quite loose, so as to afford a very easy escape to the mercury. This part should have been made also of iron, with a small plug of loose grained wood inserted in it. Another imperfection lays in the scale not being connected with the cistern by a brass rod, which it should have been, by which the uncertain longitudinal expansion of the wood mounting would have been counteracted. A very strong corroboration of the remarks of the late Lieut. Braddock on this last imperfection may be seen in the instrument examined. The scale is 14 inches in length, and is attached at each end

to the wood mounting by a screw. In consequence of the shrinking in the wood between these points, the scale had bowed out, and the person who had used it had therefore removed the screw at the upper end; and it could be easily seen, from the hole of the screw which was worked into a piece of brass no longer coinciding with the hole in the scale, that the wood within the length of this 14 inches had shrunk in length full one-twentieth of an inch, and therefore the whole instrument has decreased in length one-tenth of an inch—yet the scale very absurdly professes to give the height of the mercury to the 500th part of an inch. I am unable to see any advantage in this plan for a portable barometer, and on the contrary have pointed out undeniable disadvantages.

4. The object to be gained in a portable barometer is principally to prevent the column of mercury striking too heavily against the top of the glass tube, which may, I think, be easily gained, by making the cistern wholly of iron; in the bottom an iron screw may be placed, the point of which has a piece of India rubber attached to it, and which being screwed up will close the bottom of the tube. A very fine capillary passage should be worked down the point of this screw, and out laterally, so as to allow of the *gradual* descent of the mercury, in case the instrument should be placed upright, and also of the expansion in the tube. Such an instrument could only be destroyed by inverting it with a jerk after being held upright.

5. Guy Lussac's plan of the syphon barometer is the best portable instrument I am acquainted with, and I consider the instrument here described as constructed for me by Messrs. W. and J. Jones of Holbourn, London, to be the best adapted for use in India.

6. The case is constructed solely of brass, it is 36½ inches long, and is formed of two brass tubes, about seven hundred parts of an inch in thickness, joined together by a short brass cylinder between them, into which they are both screwed, the upper being seven-tenths of an inch in diameter, and the lower nine. The top and bottom are closed with screwed plugs with rings. In the front and back of each of these tubes, a slit, 9 inches long, and a quarter of an inch wide, is worked, through which the glass tube is visible. On the edges of these slits the divisions are laid off upwards and downwards from a central point. On both the upper and lower tubes, two short thin brass cylinders, each ¾ of an inch long, slide freely. On the lower part of the upper of these pieces, on each tube, a milled ring works in a groove, and the upper part of the other cylinder, having an external screw cut on it, works into an internal screw cut in the brass ring, by which on turning round the milled ring, the lower portion of each of these cylinders is raised or lowered about

three-tenth of an inch, so as to allow of an adjustment in this manner to the upper surface of the mercurial column, as seen through the slit. In each of the lower pieces of these sliding cylinders, a portion is cut out ½ an inch long and a ¼ wide. The sides of the notch thus formed coincide with the line of the divisions, and on one of these sides the vernier is cut; the bottom of the lower piece of the sliding cylinder being the bottom of the vernier, and being brought as a tangent to touch the top of the mercury. The back and front part of the bottom of this piece, being both made to apparently touch the mercury, prevent any error from parallax by the uncertain position of the eye in taking the observation.

7. The glass tubes are formed in four parts, the upper is 11 inches long, and at bottom is drawn out into a capillary quill 2 inches long. A piece of tube, of a little larger diameter, and four inches long, is soldered to this tube, above the contraction, so that the capillary quill projects free two inches into the centre of this short piece of tube. To the other end of this short piece is soldered the rest of the tube, which is bent up as usual in syphon barometers, and the recurved end is finished as in Guy Lussac's plan with a small lateral hole, over which a piece of wash leather is tightly bound, or a capillary glass quill 3 inches long is inserted into the end and soldered, and a piece of wash leather is tied over the outer orifice. If the tube is of the latter construction, it is necessary to be careful after setting up the instrument to oscillate the mercury up to the summit of the tube, so as to draw out any small portion of mercury from the quill, which would make the mercurial column stand too high. By the capillary quill in the centre of the tube no portion of air can get into the top, and the tube is in no way affected by any portion of air which may get into the lower part. As thick tubes cannot be soldered together in the above manner, these tubes are necessarily slight, but packing with India rubber, so as to support them closely, for which Messrs. Jones have my directions, they are rendered quite as safe in carriage as any others. The price charged for these instruments by the makers was 7 guineas each, and one very great advantage in them is that fresh tubes can be inserted in a few minutes, which no other kind of portable barometer will admit of.

8. A very great advantage in syphon barometers is that the capillary action of the tubes is neutralized, which, in India, where but few opportunities of comparing barometers occur, is not to be lightly regarded. Experiments have not yet decided what the true capillary action in barometer tubes really is, and in Daniel's Essays it is plainly shown that capillary action in the same tube differs according to circumstances.

9. Daniel has pointed out that many barometers are made and sold in London, the tubes of which are not *boiled*, and the divisions are laid off by comparison with other instruments. This is also often fraudulently done with instruments for exportation, and when they are made with close cisterns, this fraud is difficult to detect, but in syphon barometers is easily discovered, because the mercury in an unboiled tube will not stand within an inch nearly of its proper altitude, and if the divisions have been laid off from the ends of the mercurial column instead of from a central point, the distance between the divisions, as numbered on the top and bottom parts of the instrument, will not be found to agree. Thus between 7 on the lower part, and 7 on the upper part, should be 14 inches exactly; if it is less, then the instrument has been improperly made.

10. Those who have sufficient mechanical skill and ingenuity to boil the tubes themselves, may provide themselves with instruments like the syphons above described at a much lower price by ordering the brass cases without tubes, and a stock of empty tubes to be sent; for which Messrs. Jones charge only 8 shillings each. These tubes are sent out in two pieces; the recurved part being separated, and to be attached at the lamp. But the method by which I prefer to fit them up, is the following. I bend the end of the long part at right angles, and then cut it off close to the side, so that a piece of 2 or 3 tenths of an inch projects; I then fill the tube with water, and then with mercury, and free the upper part from air, as hereafter described. I then heat the closed end gradually over a chauffer, and make all the moisture simmer up to the open end, carrying the tube gradually across the fire. The closed end is then again heated (the tube being held at an angle of 20 degrees with the horizon), until the mercury first becomes speckled and then forms large bubbles, which by making the tubes revolve, are carried gradually and spirally towards the open end, collecting all the smaller bubbles in their way. The mercury must never be allowed to boil and snap, for if this is allowed, minute portions of gas, hardly visible when cold, are carried down towards the closed end, and cannot be removed except as directed. The gas I consider to be probably hydrogen, evolved from the decomposition of minute organic substances in the tube. I find by frequent experiment that filling the tube first with water is the best method to get all the air out, instead of carefully drying the tube as generally directed. The tube being properly boiled, the part for the recurved end is to be sealed at the lamp, and the end finished as customary by blowing, and then the rounded end of a rod of glass being applied to the side of the tube, ½ an inch from the sealed end, and this being pulled when the

tube is softened, a little cone is easily pulled out. The end of this is to be broken off, and the hole thus made opened and finished, to receive the bent end of the long tube. The two tubes are then tied strongly together with thread, and small pieces of cork between, and then the junction between the tubes is to be made good with sealing wax, and when cold, an inch of mercury being poured into the recurved end, the tube is finished. Two tubes thus constructed, I have found by hourly observations for many days, never to differ one-hundredth part of an inch.

11. But the best and most portable kind of barometer for India, is with tubes to be filled *wet*, they can be carried empty, and therefore are not liable to accident, and when wanted can be filled in five minutes. The late Mr. James Prinsep, in the Journal of the Asiatic Society of Bengal, has pointed out the advantage of this plan, and by frequent experiment, and during long continued series of observations, I find tubes thus filled are perfectly comparable together, and also with boiled tubes; the only precaution necessary is to make the column of mercury touch *the top of the tube* by inclining the instrument about a minute before each observation. To fill tubes thus, I use a little funnel of iron with a small point and capillary tube attached to it. Having filled the tube with mercury, it is to be set upright in some mercury in a cup, on which half an inch of distilled or rain or any clean water has been poured. By raising the end of the tube a little above the mercury, all the mercury in the tube will descend, and its place be supplied with water. The tube is to be then refilled with mercury, and again set up in the cup, and again raised a little, so as to let one inch of water only ascend to the top of the tube. A quantity of air bubbles extracted from the water will ascend into the vacuum, and the column of mercury is to be oscillated to assist their escape. The tube is then to be inclined until it is filled, and the end being closed with the finger, it is to be removed from the cup and inverted. The bubbles of air which had collected in the top of the tube will now ascend to the open end, as also the water which had been exposed in the vacuum. Mercury is then to be poured in until the water has reached the open end, and the tube is then to be set up again in the mercury, and while upright the end is to be closed by the finger, and inverted, by which the rest of the moisture in the bottom of the tube will be exposed to the vacuum; after which the tube is to be again immersed in the mercury in the cup, the vacuum being still preserved with the finger, which is then to be gradually removed. The tube is now to be gradually and very gently inclined until the water touches the top, and it is then to be removed and in-

verted, when any bubbles of air in the top will ascend to the open end, the water in the tube assisting its escape upwards. The tube is then to be completely filled with mercury, and allowed to stand five minutes, for the mercury to settle down. On setting it up now in the mercury, if the operation has been properly done, it will be found that the mercury will not fall in the tube, unless the tube is jarred heavily against the bottom of the cup, shewing thereby that the air has been completely extracted. Even when dirty, the tubes answer nearly as well when thus filled. Quilled tubes as before described may be thus used, and they are easier freed from air than the common plain tubes. As they are not required to be heated it is unnecessary to solder the parts together, and the upper quilled part may be made only six inches in length, and the lower portion may be joined to the upper by a sealing wax joint. When such tubes are required for high altitudes where the mercurial column is less than 24 inches in length, the lower portion of the tube may be shortened, by cracking off a piece, as it is better to keep the top part as short as possible, it being then most easily freed of air.

12. The instrument which I prefer for measuring the altitude of the mercury is very portable and simple, and Messrs. Jones have the minute directions necessary for making it. The following is a general description of it. It is formed of a solid piece of dry mahogany, 39 inches long, 2 inches wide, and 1½ inches thick—along the centre to within 2 inches of each end, a groove three-quarter inch broad and the same in depth is hollowed out. Across the bottom of this groove a piece of plate glass 1½ inches wide is let in level with the face of the piece of wood. This glass forms the cistern for the bottom of the tube, and allows the surface of the mercury to be distinctly seen. The tube is laid in this groove loosely with cotton, and a flat piece of brass, which turns on a pivot across the top of the groove, keeps it in its place. The wood on the right side of the groove is cut away to allow a brass bar, six-tenth inch wide, and quarter inch thick, and 32 inches long, to be fitted in there. This bar is divided into inches from a standard scale, at a noted temperature, and serves to measure the length of the column. It is not fixed, but can be moved up and down about ¼ inch by an adjusting screw, to allow an ivory point which it bears on its lower end to be brought into exact contact with the surface of the mercury in the cistern. The vernier slides on the upper part of this bar, and has an adjusting screw also. The tongue attached to the vernier turns on a hinge joint to give room for putting in the tube. A cover, formed of a piece of mahogany of the same length and breadth, and ½ inch thick, is

attached to the left side of the instrument by three hinges, and closes by 3 hooks and a small lock and key. Hollows cut out in the cover admit the heads of the adjusting screws, and in it are also imbedded a small delicate thermometer, a hook with a conical screw, to screw into a tree or post, to hang the instrument on, and an ivory plate with the aqueous tension in inches engraved on it from 32° to 120° of Fahrenheits. A brass swivel ring attached to the top screw serves to hang the instrument up by.

13. To take an observation the tube is filled as directed above, and the case being held by an assistant to an angle of 45° with the lower end over a plate, or handkerchief on the ground, the cistern is filled with mercury until it runs over. In this the end of the tube is immersed while closed with the finger, and it is then laid in the groove, the securing piece of brass turned down, and the instrument held vertical, the surplus mercury in the cistern running over into the plate or handkerchief. The bar is then screwed up as far as it will move, and some of the mercury in the cistern, is allowed to run out, by a little channel through the wood, which is stopped by an ivory pin ; until the end of the ivory pin attached to the bar becomes visible (which projects about six-tenth inches below the edge of the glass plate). The point is then brought into exact contact with the mercury in the cistern by the adjusting screw, and the height read off by the vernier. As tubes ½ an inch diameter in the upper part, can be used in this manner, the effect of capillary attraction is avoided, and the length of the mercurial column, added to the aqueous tension for the temperature, gives the correct pressure, with a degree of precision never exceeded in portable barometers, and comparable even with the best standard instruments.

14. In publishing barometrical observations, whether for altitudes or for a series of meteorological observations, observers should be always careful to describe their instruments, and to give certain evidence of their being in good order. For want of this many series of observations recorded, are hardly worth the trouble of making them ; and it must be recollected, that having compared a barometer at one time with a standard instrument, is no proof of its being in good order at another. It might seem to some that the last remark was somewhat gratuitous, but in turning over some recorded meteorological observations, I find a gentleman remarking that his barometer "had been compared with Mr Prinsep's standards, and had proved correct, and that it had *since* been *emptied, and the mercury purified*"—which is almost as much as to say that his observations were worth nothing, although Sir John Herschel in remarking on them was too polite to say so. In general

a single tube barometer is useless for nice observations, unless it has been compared with another, even if it is in good order, for the capillary action in the tube *can never be valued* unless by comparison with a barometer which can be depended on. The double syphon tubes I have above remarked are free from this defect, but whatever the construction may be, the mercury in a good boiled tube must be free from specks or cloudiness throughout its whole length ; and it must *jar* against the top of the tube (not *bump*), as a bar of steel might be supposed to do.

15. Since the above was written, I have had the opportunity of examining another of Newman's barometers, like that described in para. 3, and I found the lid or cover of the cistern so shrunk and loose, that nearly all the mercury had escaped, and also that the tube had been attached to the cover by glue and tow, which, in the damp weather in this climate, had been softened so much, that the mercury had been forced completely through the joint. As there are many of these instruments in India, the following directions regarding them may be useful.

16. Whenever any mercury has been found to have escaped into the case of the instrument, it may be generally considered as certain, that it has become useless until put again into order, and it should in consequence be carefully kept with the cistern upwards, because if set upright, some air might get into the tube, and render necessary the trouble of reboiling the tube. The brass ring at the bottom of these instruments has 6 brass screws in it ; the three nearest the wood attach the ring to the wood, the lower three screws are screwed into the wooden lid of the cistern. In the lower piece of brass by which the bottom of the cistern is turned, there are two iron screws, which open into the cavity of the cistern ; care must be therefore taken that they are never taken out except when necessary to take the instrument to pieces. The three brass screws which hold the cover of the cistern being removed, the part of the cistern which is movable being pulled, the cistern and tube will come out easily, but great care must be taken not to turn it round in the least, which would snap off the little thermometer. To put a barometer of this kind in order, if any air has got into the tube, the first thing to do, will be to ascertain if the lid of the cistern is tight. The two iron screws in the movable bottom piece being removed, the brass cap may be pulled off easily, and the cistern and tube, can be filled with mercury through the holes. The cistern being quite full, the tube is to be held downwards, and the bottom of the cistern turned round a quarter turn. The tube is then set up in an erect position, and on jerking it slightly up and down, if the lid of the cistern is loose, the mercury will

spurt out in radiating streams, all round the juncture with the cistern. To remove the cistern, a small iron screw in the edge of it must be sought for and removed, and it can then be screwed off the cover. To remove the cover of the cistern from the tube, it must be soaked for a day or two in water at 140 deg. Farhenheit (hotter would break the thermometer), which will soften the glue, and the tube and thermometer must both be pulled out. The interior of the tube must then be washed quite clean by filling it with distilled water, and emptying it again several times. Generally a little dust of black oxide of mercury will be found in it, which must be removed by dropping some nitric acid into it, and washing out again with water. The tube is then to be filled wet with mercury, and freed from air, as directed in para 11, and then boiled. To cement the cover of the cistern on to the tube again, both the tube and the cover being made hot, some sealing wax is to be applied around the tube, and the cover is to be twisted on, while the wax is still soft. The cistern is to be cemented also on to the cover, by heating it strongly over a charcoal fire until it is hot enough to melt sealing wax, and some wax softened in the candle being applied all round inside the screw, the cistern being held by a thick cloth is to be quickly screwed again on to the cover. When all is cold, the hole for the thermometer is to be closed by a piece of soft wood, and the cistern being filled with mercury through the two screw holes, the bottom is to be turned, and the surplus mercury in the bottom is to be allowed to run out. The screws having been inserted, the bottom is to be turned again until the mark on the two pieces shews that the openings coincide, and the tube is to be held upright. The next thing is to insert the thermometer, which is now to be put into its place and cemented with some putty made by rubbing chalk fine with wood oil, which will dry in a couple of days. But as the thermometer is of no use, as it will not shew the temperature of the mercury in the tube, where all the hottest mercury of course ascends, it is better to remove it altogether, and to stop the hole tightly with a deal peg. A thermometer attached as in these instruments, is the more inconvenient, because very liable to be broken, and then of course might endanger the whole instrument by letting the mercury out of the cistern. To finish the barometer, nothing more is afterwards necessary but to adjust to its old neutral point, by comparison with a good barometer, by adding or removing a little of the mercury in the cistern by the screw holes.

V.—*Account of the Basava Puran;—the principal Book used as a religious Code by the Jangams.*—*By* C. P. Brown, *Esq.*

The description of the Jangams, given in a former essay, may shew how far these Vira Saivas differ in their creed from the other Hindus. To render the view of their state more complete, a sketch of their popular literature may be advantageous. Legendary lore is puerile enough in all countries; and is not worse in India than that which prevailed in Europe, before the invention of printing. That of the Jangams deserves notice, because forming the creed of a large body of Hindus, who venerate the Basava Puran as sincerely as Bramins do the Ramayan.

The *Puran* or legend of Basava was originally composed in the Telugu language by Palacuriki Somanatha, who likewise translated the *Pandit Aradhya Charitra* from the Carnataca language. This poet lived in the days of Pratapa Deva Rayalu, also called Praudha Rayalu, who appears to have ruled the Telugu country from A. D. 1456 to 1477.* That the poet was cotemporary with this prince is stated in the introduction to the modernized (padya metre) version of the Puran, written by Piduparti Somaia.

That introduction further states that the "Charitra" was versified (written in padyams) by Sri Natha, the well known poet who translated the Naishadham into Telugu.† Indeed the antiquated style in which the Puran and Charitra were originally composed, is (though still extremely popular) so rude and inelegant that modern poets have re-written these works, as Dryden and Pope have remodelled the poems of Chaucer and Donne.

After Somaia had translated the Puran into *padyams*, he proceeded to translate the Lila from Carnataca verse into Telugu dwipada. His uncle Basavaya had already written a *padya* version of the Lila; as also of the *Dixa Bodha*, the *Pilla Nayanar Catha* and the *Bramhottara Khandam*. None of these works equal in beauty of style the *Puran* and *Lila* in the *modern* version, written (perhaps about A. D. 1600) by Somaia. Hindus are always apt to give a fictitious antiquity to their favourite authors: and late enquiries have shewn me that the dates mentioned in a former essay require correction.

Some of the more popular legends are contained in books which are con-

* See the chronological series of kings, framed by Col. Mackenzie, and printed in Mr. Campbell's Telugu Grammar.—See also note at end of this article.

† I have not succeeded in obtaining Sri Natha's version: but have in my possession all the other volumes here named.

sidered *Purva Saiva* or braminical; such as the story of Bhallana, that of "Chennappa the savage," and a few others; which are given not only in the Basava Puran but likewise in the *Sri Calahasti Mahatmyam*, in the *Vaijayanti Vilasam*, the *Vira Bhadra Vijayam*, the *Raja Sekhara Charitra*, and some other Canarese and Telugu books, not written by Jangams but by Bramins; and accordingly dedicated not to Basava but to Ganesa or Rama.

These legends, again, are distinct from those (now wholly obsolete) which are given in the Siva Puran and Linga Puran: of these a summary may be seen in the preface to Professor Wilson's translation of the Vishnu Puran. Here, as also in his "Two Lectures" (lately re-printed at Madras*), the learned professor points out that "the wise look upon "the outward emblem as nothing; and contemplate in their minds the "invisible inscrutable type; which is Siva himself. Whatever may have "been the origin of this form of worship in India, the notions upon "which it was founded, according to the impure fancies of European "writers are not to be traced in even the Saiva Puranas."

The *Siddhānta Sékharam*, the *Siva Siddhanta Tantram*, and the *Suprabhéd Agamam* do indeed describe the lingam; but these are *braminical* treatises of modern days, written in Sanscrit. In the *Tantras*, of which an outline may be seen in Professor Wilson's Two Lectures (as also in my former essay), there is not the slightest allusion to the lingam. In the books now to be described, all the legends inculcate devotion to this image of Siva: but regarding the image, or its origin, there is not a single syllable.

The *Purva Saiva* being the *ancient* or braminical creed, offers homage to the image placed in a pagoda or in any sacred situation. The Jangama or *Vira Saiva* is the modern anti-braminical creed,† wherein each individual wears the image. The ancient form directs pilgrimage, penance and sacrifice: the modern substitutes (Guru, Linga, Jangam) devotion to the teacher, adoration of the image, and benevolence to the fellow worshipper. The older form admits of caste, and considers Bramins as sacred. The modern rejects caste, and certainly teaches no veneration for Bramins. In the modern creed every homage is paid to *Basava*, and paid exclusively to him as *Siva*: paying no regard to Parvati, to Ganésa, to Nandi, or any other attendant on Siva: in the older or braminical system (such as is taught in the Calahasti Mahatmyam

* On sale at the Athenæum Library.

† Opposing the braminical superstitions as vehemently as the *Wahabi* creed opposes the older Musulman sects.

and other books named with it) the name of Basava is never mentioned.

The Basava Puran is in seven books, containing (in the original Telugu dwipada) 12,700 lines; it is an evident imitation, in some points, of the braminical puranas; for instance, the introduction declares that to pronounce the three syllables *Ba-sa-va*, and the syllables *Gu-ru*, is a means of obtaining heaven: and that faith (bhacti) is the great foundation of good. The book purports to be a series of legends regarding various devotees (bhactulu) or zealots who attained *faith;* and details the miracles performed by these "worthies." These (in imitation of the braminical mode) are narrated by the god Siva to his wife Parvati and the sage Narada. The book opens with homage paid by Siva to Basava, who is declared to be an incarnation of Nandi (the Apis or sacred bull): and a few of the latter legends are concerning this confessor (Guru) Basavesa, closing with his death; but the greater number of the stories have nothing to do with Basava, and merely describe the devotion of various saints, who lived in ages previous to his birth. These are introduced as being narrated by Basava, or in his presence. The first book describes Basava's parentage and birth as given in the former essay; and then gives the following details.

In his eighth year his supposed father, being a Bramin, wished to invest him as usual with the braminical thread: appointing him a (guru) confessor or teacher. But Basava replied the great Siva is my teacher, and I desire no other. The father tried to persuade him that the *Bramhachari* state, into which this rite introduces children is itself emblematic of Siva. These words greatly offended Basava, who replied "you "speak of ordinary braminism and faith (bhacti), as if they were one and "the same: whereas the *yajna* rites declare bramanism and faith to be "quite distinct. There is no specific form of God as a visible shape: "he is dead in his works who believes that the deity can dwell in a spe-"cific form. None can attain eternal happiness unless he meditates on "the (lingam) image, using the six-syllabled spell (Om Namasivaya) "with adoration, and the rosary (rudrāxa) and ashes. Further, divine "bliss (linga-para-saukhyam) has not been expounded even in the "Vedas. Some assert that a religious profession (brāmhanyam) and "faith (bhacti) and spiritual intelligence (darsanam) are all one; but "profession exists merely in the homage paid to gods, &c. and he who "thus is tied to works has not faith. There is a wide distinction be-"tween profession (āchāram) and faith. Faith in the god is the hon-"ourable wife: whereas profession is the (jāra-strī) harlot. Consider "that Brahmins, when invested with the thread commence the rite with

" the adoration of (Nandi) the sacred bull: then why should they de-" part from faith in Siva? surely faith in Siva is our highest object.

" Again: the ties between our parents and ourselves are mere de-" lusion, I will therefore depart from you," &c. &c. Basava then leaves his father's house accompanied (as formerly described) by his sister Nagamāmba; they go to the house of his father's brother, whose daughter Gangāmba he marries. Basava then departs with his wife and sister to *Sangameswara* the abode of his patron god; while offering his prayers here the god Siva appeared to him, embraced him, and stood before him with joined hands; lauding him, and encouraging him to continue steadfast in the faith: and declaring that even an enemy who adores the image, is to be regarded as a friend: he desires Basava to shun all intercourse with such as adore not the image. He further said "Look upon every Jangam as being verily myself."

The Second Book describes the reign of Bizzala, king of Calyanam, whose minister was Basava's uncle: on whose death Basava was made minister; he accepts office on the condition that the king will relinquish the Jaina creed, and become a worshipper of Siva. Basava now devotes himself to hospitality to the Saivites: and washes the feet of his guests.

He appears to have at this time contemplated making some innovations in the religion. He having declined the braminical initiation, the legend declares that at the time of his birth, the god Siva himself descended and breathed the spell (*Namasivaya*; see former essay) in his ear. In other words he framed or adopted the formula for himself, and now communicated it to his nephew Chenna Basavana: this was the son of his sister Nagamma: but here is no mention of his other sister Padmāvati, whom the Jainas say Bizzala took to wife (see Mr. Elliot's remarks, in this Journal, Jan. 1838, p. 212). The legend here asserts that Chenna Basava is a secondary form of Basava himself: the teacher and the pupil being one.

Basava now receives a visit from Allama Prabhu, of whom a short account has already been given in the former essay. Basava adores him as being Siva himself; and Allama is described as bearing the image in his hand. Allama probably is a fictitious personage: he is described as being one with Basava: but from the circumstances we may conclude that at this period Basava determined on wearing the image. For he is not stated to have already bestowed it on his wife nor on Chenna Basava. At his birth indeed, Siva is stated to have himself descended and placed the image on the neck of Basava: but we cannot suppose that being the child of a Brahmin he was permitted to deviate from the fixed dress of the caste.

Here also we first find the mention of *Māhēswarās*, that is, *Jangams*; who are introduced as a sect already known. But this style probably is used merely to avoid the idea of innovation, for Basava declares repeatedly that all who are devout adorers of Siva are his brethren. And throughout this book we find him lavishing his bounty and his worship on pariars or others who are faithful worshippers of Siva. And it is evident that very few of these are Jangams.

Then follows a discourse intended to prove that faith (bhacti) is all in all. That this is the one boon to be sought; and that faith makes the (bhacti) adorer equal to the deity. At the close of this conversation Allama blesses Basava, to free him from the power of sin. He then is "resolved into the image" (ling-aikyam), which here is interpreted that he vanished; but this phrase is elsewhere used to denote death.

Basava then devoted himself to mystic abstraction (Yōga-sastram), and continued his bounteous treatment of the Jangams, "gradually being more and more absorbed in the image as camphor is absorbed by fire."

The next legend describes some robbers who gained access to Basava by wearing on their necks beans which they feigned were (lingams) images. On examination the beans are found to be changed into images. On another occasion he converts a heap of corn into pearls.

Many miracles are related regarding other saints: and some are narrated by Basava himself.

In the Third book Basava distributes in charity the treasures of his master the king. But the treasury is still as full as ever. This introduces another story, wherein a minister who had embezzled money given him to purchase horses, collects some foxes and turns them into steeds. In the next legend one of the Jangams requests Basava to give him a silk dress then worn by his wife Gangamba. She is accordingly desired to strip it off; and does so; but in the usual mode it is merely a long sheet, and as fast as she unrolls it more and richer dresses appear under it. The Jangam then cuts off as much as he requires. This is a mere imitation of a story in the second book of the Mahabharat, wherein Draupadi is thus miraculously clothed.

The next set of legends is regarding the (mudha bhact), or *silly saints*—whose feats certainly rival those of the simpletons (ahmaq) described in the Musulman pious legends. These idiot monks, who have bid farewell to common sense always receive peculiar honour among Hindus of all creeds. Several of them are called Minda-Jangams or libertines (as mentioned in the former essay); and absolutely do not know right from wrong. This exalts their merit; as the force of their faith atones for every other deficiency.

One of these is a pious woman who ponders how it should happen that Siva should have every relation excepting a mother.* She reflected on the grief she suffered at the loss of her own mother ; and, imagining it might comfort him, she longed and prayed to become his mother. She thereupon adopts a boy ; but, to try her faith he occasionally abstains† from the breast as a fast. She imagines the boy to be unwell, and as he will not tell what ails him, she is about to knock her brains out (as usual in these fables) when he bursts out in divine form as Siva : and offers to grant her every wish. She makes no request and he bestows on her (sayujiam) eternal happiness : and she is now worshipped as saint Ammavva : having been a mother (amma) to Siva.

A man and his wife who daily offered boiled milk to Siva leave home, directing their daughter to attend the god daily. She one day put the milk before him, and bowed to him as she left him to drink. On her return, she finds he had not drunk it. She begs to know what had offended him : as he remains silent she offers (as usual) to knock her head against the wall ; but the god took pity on her and drank the milk. This he continued to do daily until it happened that on coming out she met her parents who asked her for the milk in the vessel. She alleged that the idol had drunk it. This they disbelieved as he did not eat what *they* offered. They therefore took the girl to the image to repeat the story to him. She bowed to the figure who opened his bosom ; she entered and the marble closed again. Her father caught her by the hair ; which therefore did not enter, and still continues to grow ! so that they keep it cropped.‡ Could you desire proof more complete of any miracle ?

The next legends are yet more marvellous : but they certainly have this negative merit, that they are free from the foulness of the braminical legends, and we find none of the curses therein inflicted, as absurd as they are cruel.

Some of the tales are merely ludicrous. Thus one of these simpletons sees a statue of Siva dancing. He imagines the god is contorted with rheumatism. The story ends as usual by the god carrying his worshipper to (Cailas) Olympus.

* Compare the Legend of Saint Kentigern, as narrated in the second volume of Southey's *Sir Thomas More ;* or, *Colloquies on the Progress and Prospects of Society.* There we even find the story of a fox or wolf used in lieu of a horse.

† Like Saint Nicholas, the patron of thieves, who is noticed at a subsequent page. When an infant at the breast he fasted on Wednesdays and Fridays.

‡ There is a similar story regarding St. Francis. Compare also Napier's Lights and Shades of Military Life, 1840, vol. 2. p. 87, the story of a crucifix, the nails of which they are obliged to cut from time to time.

The next legend is that of "Cannappa the (boya) savage." This story is remarkably popular; it is narrated in various books: and many Hindus at this day are named after this worthy. In the *Sri Calahasti Mahatmyam* the story is given in great detail, but may be summed up briefly. Cannappa (who is one of the *silly saints*) is a forester, who in a dream beholds Siva in the form of a hermit: and is directed to plunge into the forest to seek the god. He next day pursues a wild hog into the wood; where it vanishes and he finds an image of the lingam. Here the god appears to him: the lad recognizing him, invites the god home. The god was silent, and Cannappa imagined this might be the effect of hunger: so he went to bring him venison. Another story is here introduced to shew how the giants turned themselves into wild animals, in the hope that being slain by the blessed hand of Cannappa they should obtain (moxam) heaven. Cannappa now daily brought flesh of wild hogs and deer with which he fed the god: but a Bramin hermit who lived near the spot was offended that Cannapa, being a pariar or outcast should thus gain the favour of Siva, while he himself daily exercised an unprofitable devotion and offered fruits and milk to the image. Here the Bramin introduces the following story. Once upon a time, a devout spider* built her web so as to shade the image; which a devout but jealous elephant tore down and daily bathed the god: which he supposed to be a more acceptable homage: but the spider became a snake and got into his trunk and killed him. Now I, a weak Bramin must thus contrive by cunning to kill this brawny forester. While he thus plotted, the god determined to put the forester's faith to proof. There was as usual a single eye painted on the image. From this eye Cannappa perceived tears were flowing: which he wiped away with his shoe; and then filled his mouth with water which he spirted over the image, which now poured forth a stream of tears. He begged to know what was the matter, *whether the god was in want of food for his wife and children.* Perhaps, said he, you want another eye: if so take one of mine! so saying he pulled out one eye and presented it: but the image still wept: so he pulled out his other eye. Whereupon the god appeared in his true form and restored his eyes.†

The poet now proceeds to extol this saint, declaring that *to be touched by the spittle, and the shoe of this saint was no small honour to Siva.*

* In this legend Sri is asserted to be a Sanscrit word for a spider; a meaning found in no lexicon.

† Compare the legend of Saint *Lucia* at *Naples*, who in like manner tore out her eyes, and had them restored.

And as a satisfactory proof of this story he refers us to the temple at Calahasti, where the image of Cannappa stands facing the image of Siva. There they *first make offerings to the saint* and then *give the leavings* to Siva: they *rinse the mouth of the saint*, and then present this as *holy water* to the god!

This concludes the eight legends of the "childish devotees;" and they are not represented as followers of Basava, who was born in a later age.

The *Sri Calahasti* legend (a separate poem in four books, translated from Tamil) gives this story with the additions that the *spider*, *snake*, and *elephant* (*sri*—and *cala*—and *hasti*) mentioned in this story were adopted by Siva as his devout servants.

The next legend is remarkably popular, and has furnished the theme of several poems. It is the Legend of Sri Sailam, a pagoda on the river Krishna in Curnool: described by Colonel Mackenzie in the 5th vol. of the Asiatic Researches.

A baron named Sacal Esa Madiraz ruled the town of Nambi: he was a great musician, and devoted his talents to the praise of Siva. Paying a visit to *Mallarusu*, a saint who lived at Sri Sailam, he admired that sacred hill: and particularly the *quaking* or *dancing* hillocks: [here is given a long description of Sri Sailam]. It is here stated that Mallarusu was in fact Mallic Arjuna: a personification of Iswara: and to try the faith of his visitor, the god assumed a strange shape, wherein neither his head nor his feet were visible. The pious Madiraz adored him as incomprehensible. The god was well pleased and brought him into his temple where he invested him with the *image*, and told him that as long as he dwelt on earth he must be subject to the (carma canda) law of works. But Madiraz refused to return to earth, and thereupon the god caused a *tumma* tree to spring from the soil, and under it he directed him to dwell. While he lodged there the god again approached him in the guise of a herdsman, and began to hew down the bough that gave him shade, while he sat at his devotions. Madiraz was angry and forbade him to commit such a sin. The swain replied, thy being angry is a sin, for he who gives way to anger is a sinner. If this annoys you, you may go and seat yourself elsewhere. Have you never heard the adage of the flood, at which a bear came swimming down the stream? a man thought it was a sheep, and in attempting to catch it, he was seized by the bear. Thus you sit here in the hope of vanquishing (maya) the earthly passions, and are yourself within their power, as the man was seized by the bear.

Madiraz, however, persisted in reviling him: while he replied by preaching patience: at last the god blazed forth undisguised. Thereupon Madiraz entreats to know how eternal happiness was to be attained: and is answered that he must again descend to earth; that at present there was on earth the great saint Basava; and, said he, go and listen to his preaching, and I will shortly summon thee to this place. Go now to the city of Calyanam, where thou shalt find Basava.

On hearing these words the saint saluted the god, and the next moment found himself at Calyanam: where Basava had by a dream been warned of his approach and received him with honour. This closes the third book.

The fourth book contains the life of a celebrated saint named Madirāla Māçaiia, who was a washerman by trade, and one of Basava's earliest proselytes. He performs great miracles; a touch of his hand slays an elephant; and a second touch revives him. This man and other devotees lay themselves under a vow to cherish or aid the Jangams in some specific mode, such as washing, making clothes or shoes, &c. for them. A variety of such stories are here inserted as being related by Maçaya to Basava. One saint receives a sack of corn from a woman: at his touch they vanish, and at the same moment all the wealth of the sender disappears; this being intended as a punishment for her feeling pride, at making so liberal a donation. Another saint is gifted with Siva's eye (as destructive as that of the *caliph Vathek*), and entering a Vishnu temple, he *consumes* the luckless *statue* of the god! Another devotee named Chiri Tondan Ambi is extolled as having, with his wife, hospitably received Siva (disguised as a Jangam) and at his desire *to be feasted on human flesh*, he and his wife *roast their son* for dinner. On sitting down to table the god desires them to call their child to dinner. On being called the boy re-appears alive.* Hereupon the god shines forth and carries the whole party home with him to Cailasa.

It is believed that this Tondan Ambi was in this manner carried seven times to Cailasa from Canchi: and is to repeat the journey once more at some future period.

The next legends are equally wild. Narasinga Nayanar was king of the Chola country: his wife one day went to worship at the pagoda, and happened to smell to one of the flowers, which were to be presented to the god: whereupon the priest cut her nose off. Her husband ap-

* Saint Servan performed a similar miracle on a pig: as is narrated in the life of Saint Kentigern.

proved and cut her hands off. Whereupon Siva blazed forth, restored his wife her limbs, and carried the pair to Cailas.

There are several stories to show how Siva was born in various places as the son of various devout women. This appears to be a mode of stating that their sons were pious men.

Several of these saints vitiate their sacrifices by a feeling of pride: whereupon they are punished in various modes.

The next story is regarding Miru Mindu Nainar whose faith exalted him so greatly that Siva (by the name Vālmīk-esa) became his servant; nay his slave, and pander. The other devotees hereupon curse both the god and his pet as equally infamous. "At these words the god was so "frightened that he fled and took his pet with him: they stole round "the idol, and passing under its front they ran away into the jungle." Siva's follower *Nandi* expressed his wonder that a god should suffer such distress: but Siva replies, "I and my followers are one: nor can I be free from grief while they suffer. Indeed on a former occasion, when a devout woman was ordered by the king to produce a militia man, as the fee on her land, I myself went and served* as a soldier furnished by her." This "shews the wonderful power of faith: the good deeds of a former birth would never suffice to obtain such a boon. Wert not thou proud, O Nandi thou wouldst attain *oneness* with me."

Here Basava is informed that Nandi ultimately became thoroughly humble; and this gained him the honour of canonization.

"And next to faith, charity is the great means: for example this Nambi after bestowing all he had on the poor, proposed even to bestow his body in alms. He began by cutting off his hand: whereupon he was at once borne to Cailasa."

To this succeeds a series of miraculous stories, inculcating bountifulness to the poor: some devotees after reducing themselves to poverty attempt suicide: whereupon they are as usual carried to Cailasa. Several of these tales are interesting, but they are very long. One of these men is visited by Siva disguised as a Sudra who refuses to honour the god adored by his Jangam host: the zeal of the host is aroused and he attempts to slay his guest, who thereupon displays his real form and carries the zealot to Cailasa.

The narrative concludes with the moral that faith avails nothing if clogged with pride. Pride ruined all the pious acts of Nambi, who therefore long lingered on earth.

* Parallel to the Romish legend of the Virgin Mary, taking the place and doing the duty of a devout nun who eloped for a period from the convent.

The book closes with praise of Basava as being really the god Siva.

The fifth book commences with the life of a very celebrated saint, Kinnara Bramhaya (or, Bramhaya *of the harp*). He distributed all his goods among the Jangams and then lived as a harper. Hearing of Basava's liberality to all the worshippers of Siva he resorted to him. After dwelling with him for some time Bramhaya one day saw a (vitaca) gallant carrying a sheep to his mistress. The sheep escaped and ran into the temple of Siva. Bramhaya begged it might be spared, on the plea that it had thus offered itself for sacrifice : so he offered to pay for it : the price being half a (varaha) pagoda : but the man demanded 2,000 pagodas for it. This money he obtained and paid. The man then got two other sheep for the woman ; but she chose to demand the original sheep alone. He therefore attempted to wrest the sheep from Bramhaya who in the struggle cut off the man's head. His relations complained to king Bizzala, who sent for his minister (Basava) and reproached him with the deeds of his fellow zealots. Basava recommended an enquiry into the circumstances on the spot. The king therefore repaired to the place, and the god was called on to bear witness. Siva thereupon burst forth in divine form in flames and thunder, which ceased at their entreaty : the king then offered homage to Bramhaya who consented to restore the dead man to life.

The next four legends are full of miracles, but they are not so popular as to call for notice. We may remark that in these stories Basava is by no means exalted over his brother zealots. It is stated that (on visiting a very charitable woodman, named Moliga Maraia) Basava looked upon himself as sanctified by eating in the house of so excellent a person ; he even envied the birds and beasts that were at this holy abode. On Basava's offering homage to Maraia, he replies by attributing divine honours to Basava, saying all I do is by thy grace : Basava is much shocked at this homage, and replies, have mercy on me a poor inferior creature : as far beneath thee as a crow is beneath an eagle ; for I am the very abode of all sin.*

The next legend is regarding Cannada Bramhaya, a saint of a singular temperament, being (like saint Nicholas) by trade a housebreaker. If on breaking into a house he found that the inmates were worshippers of Siva, he spared them, but shewed no such delicacy towards those as were not of the true faith. He once was digging through the wall of king Bizzala's treasury, and on entering he met Basava, who being the trea-

* His crossing the river dryshod is another incident paralleled in the legend of Saint Kentigern.

surer, invited him to walk in and help himself. On hearing this the king was much displeased, he came to the treasury, found the hole made and the money lying about. On asking an explanation of the affair, Basava told him that this was the doing of Cananda Bramhaya (Bramhaya the *borer of the spade*), who is a great saint The king raised a query, how a house breaker could be a saint. Basava replied that he bestowed his plunder on people of the true faith* ; adding that he had broken into the treasury with the best designs towards his majesty. Then the thief carried home a party of the Jangams and gave them a dinner.

In the next legend a saint feasts his friends on poison nuts, which prove harmless. Another raises a corpse from the dead. In the next story narrating a journey made by two devotees, there is mention of a fig tree called the *Basava fig tree* : so called from two bulls (the word *basava* meaning a bull) having fought on this spot. On approaching the tree they see the deity (Basava) therein and worship him. They next cross a river dryshod, the stream giving way before the brandished sword of a devotee. The blessing given by a saint to a virgin wishes her a century of life : but she next day dies, and he restores her to her parents.

In the next story certain (ajnulu) unbelievers dress up a semblance of a corpse which they bear before the house of a saint to see if he could detect the delusion : but he went up to the bier and took the doll up by the hand and raised it to life. This of course persuaded his opponents of the truth of his creed.

Another saint named Suraya Candaia who worshipped Siva, used to pay yet greater homage to the Jangams : for he adored them first, and the image afterwards : thus reversing the usual rule. Another used to listen to his guests while eating, and declared that he heard Siva himself masticating. Nay he literally fed the *image* hanging at his neck, which actually ate with him. Another saint and his desciple are visited

* Precisely the doctrine taught in Parnell's tale of *The Hermit*, wherein the angel steals a gold cup which he bestows on a miser. It frequently occurs in Hindu writings. Thus in Vemana, III, 134. "To give away what is our own is easy : he alone can be called liberal who scruples not to bestow in gifts the property of others." Likewise in the Bhascara Satacam, verse 42, *Danamu seya cori*, &c. "If the liberal man when "desirous to bestow a gift, should lack the means, let him resort to the goods of "others : as the cloud waters the desart with streams which it borrows from ocean." The same principle may be seen in the laws of Manu ; and also in the Musulman rules regarding the right that the faithful have to the goods of idolaters. Indeed Parnell' ale has been traced to an Arabian source.

by a troop of fairies (gandharva) with their wives, who protest they took the saint for a bear, and his disciple for an ox. He therefore cursed them to be born as brutes. They were released from the curse by falling under the arrows of a worthy named Zommaia, who continued to offer seven animals daily to the image.

This story is evidently copied from that of Cannappa the savage, mentioned in the third book. It is the only Jangam legend wherein I have met with the mention of curses.*

This story concludes the fifth book: and the sixth describes those acts of the saints which were performed to confute the assertions of the Jainas. For instance; a Jaina defies a devotee named Ecanta Ramaya, and tells him that he is willing to adore Siva if the devotee will prove his faith by beheading himself. This the saint declined as inconvenient, replying that this step was superfluous; as numbers of the devout had cut their heads to Siva, and then recovered life. He proceeds to tell various legends.

In the first of these a saint cuts off his head, and recovers it at the end of three days. Another thinks this delay must have arisen from the want of faith: so he cut off his head before the god who instantly replaced it with another: and this feat was encored till the temple was full of heads. The next stories are regarding Jaina persecutions: one Jangam is condemned to the flames, but fire will not burn him. He then is released and destroys the Jaina images. Another is a blind man who as a good deed digs a well, which the Jainas fill up. He gains his sight and they go blind.

The next is a legend of Siva and Parvati descending from heaven to visit a Bramin boy, who thereupon embraces the Siva creed. This fable is very long but is narrated in a pleasing style of poetry. This Bramin is allowed by the king to hold a public disputation with the Jainas. The Jainas now by their spells invoked the god of fire to destroy him, but he remained unhurt: this is interpreted as meaning that they tried to kill him by burning his house. The Bramin now inflicts fever on the king, and the Jainas are unable to cure him. The Bramin not only cures

* A curse is the mainspring of all the braminical narrations. Throughout the Mahabharat this engine is constantly brought into play: even the present fable of Cannappa is of braminical origin: for the legend is traced to the Skanda puran. We may recollect that a curse is the first moving cause of the Iliad, the Odyssey and the Æneid; as well as in the *Bhagavat* and the *Cloud Messenger*. But the peaceable puritanical style of the Jangam books rarely admits even the mention of a curse, and this is perhaps the only instance of one of their saints resorting to that braminical weapon.

him, but removes a hump from his back. (This is one of the legends told in the Socca-Natha Lila, or, Madhura Puran).

The Jainas having declared they would acknowledge no proof save that by fire, the Bramin now wrote a Siva spell, and cast it into the flames with a Jaina spell : the Jaina incantation is burnt, and the other is preserved. The Jainas now propose the water ordeal : and the writings of both creeds are cast into the Cavary ; in this also their books perished, and the Saiva books floated.

The Siva disputant, who is named Pilla Nainar, now set up a number of iron spikes on which he impaled the Jainas. This persecution is countenanced by a king. Another account in the next page states that the Jainas were saved because they embraced the Saiva creed.

These stories regarding the Saivas and Jainas, appertain to an age previous to that of Basava.

The same narrator adds the following legend. There was a faithful devotee named Nami Nandi, who used to collect *ghee* (butter) as alms, wherewith he lighted lamps in the temple of Siva. The Jainas opposed him, and as he could get no oil he complained to Siva, using the common threat of suicide. The god thereupon appeared to him, and desired him to fill the lamps with water which burnt remarkably well. Then the god smote all the cattle that supplied the oil butter : and the people humbling themselves before Nami Nandi, the saint restored their cattle to life—and they embraced the Saiva creed.

Another saint named Sankhya Tonda, lived in the Chola country : he was the son of a Buddhist, and as he could no where find men who adored Siva, he prayed his god to destroy all the Jainas ; and, added he, until thou grantest this prayer, I will daily fling three stones at thee. At last Siva appeared, stretched out his arms, embraced him and granted his prayer by destroying all the Jainas in the town.

The next legend is of a saint named Covvuri Bramhaya, who held discussions with the Jains, and as they demanded a miracle, that of reviving a tree from its ashes, he accepted the challenge, and this convinced them.

There was a Jain guru, who was the confessor to a petty prince or baron named Desinga Ballahu. But his wife Suggalavva, had a Saiva named Devara Dasaya as her spiritual guide. She requested him to destroy all the Jainas. But the Jins* slandered him to the king, who counselled her that it was very wrong for a husband and wife to have

* Jina or Jina Deva, is the name used for the deity by the people who call themselves Jins, or Jainas.

separate confessors. She was offended and replied that a penitent is just as strongly bound to the confessor (guru) as a wife is to her husband. She reminded him that this was stipulated at the time of their marriage: and it would be better that they should separate than break that promise. Assemble your Jins, said she, and let them dispute with my confessor, and let the termination of the dispute decide our creed. This debate took place. Devara Dasaya asserted that the deity (Siva) pervaded all the universe. They replied, if your god fills all space, it surely is superfluous to assemble in temples to adore him. Dasaya replied:—"The king rules the whole country, but it does not hence follow that every one of his subjects is king. There is no occasion to attend temples as the deity is present with us all. Consider, the Chandra canta stone (selenites, amber) has the lunar influence inherent, and melts at the lunar ray; so does the heart of the pious man melt at the divine influence: for in him the deity is inherent. If we desire to have the milk of the cow we must buy the calf too: for it alone influences the udder to flow: thus none but the faithful adorer can derive any good from worship. The pearl shell rejects all common rain and is impregnated with pearls only by the genial showers of (Swati) the asterism Arcturus. In like manner the faithful Vira Saiva's heart expands to the influence of Siva alone."

They then asked whether Siva was the body or the soul of the world. He replied "Life and its properties do not appertain to the divine being. The living soul is in bondage to works but the deity acts from will alone. The deity is in our bodies, latent, as fire is in wood or oil in seeds: co-existent and hidden."

They replied saying, you say that Siva fills all space, and add that the divine influence is immortal: while the vital spark is mortal. This should be proved. Besides there must be one common principle of life extending from brutes up to deity. Explain this.

He replied, oil exists in linseed though it is imperceptible.* The deity shall be attained by the wise, no fool can attain to him for he pervades all nature. Of this I will convince you by destroying this Jaina town (a town named Potla Cheruva) and as a mark of my power, said he, tell me what is in this jar—verily the deity is therein. So saying he produed a jar containing a snake: and on opening it the snake was found metamorphosed into a crystal (lingam) image. This convinced

* I omit some further argumentation, which is tedious, and just as inconclusive as the above.

his opponents. He then pulled down all the Jaina temples and set up this image to be worshipped under the name Uttar Eswara.

The next legend is similar: describing the setting up of Saiva images in Jaina temples. The next is yet wilder. The Jainas delude a Saivite who is blind, into one of their temples and setting his face towards (Jin-eswara) their idol, assure him it is (a lingam) an image of Siva: he worships it: whereupon the Jaina image burst to pieces and in its stead there appeared the image of Siva.

The prince Bizzala (who employed Basava as his minister) now opposes the Jangam faith; being himself a Jain. On one occasion he sets up an image of the god Gopala [this is the name of a braminical god: but it is stated that this was done merely to annoy the Virasaivas]. He desired all people to worship this image. A zealot named Bāçayya refuses to obey. The king complains of this: but Basava interpose stating that if Bāsaya neglected his duties he merited punishment but he could not be expected to honour a new god.

The next legend (told in the braminical puranas likewise) is that of Bhringi, and deserves notice (though pitiably silly) merely because very popular. This Bhringi was a devout servant of Siva (Jupiter) on Kailasa (Olympus) and wished to honour Siva in the rite called *pradaxanam* (encircling him, circumambulation). But he declined paying any homage to Parvati (Juno) and as Siva was in the (Arddha nari) hermaphrodite form* (the right half of his body being male and the left female) Bhringi asummed the form of a (*bhringam*) wasp and bored a passage for himself between these figures: thus excluding Parvati from his homage. The goddess was offended at this and by a curse dried up the zealot's body, abstracting all his flesh and blood, and reducing him to *nobody*. To comfort him Siva presented him with a third leg, and in this reptile shape Bhringi (Tripos tripudians) appears in all the Siva temples, being an especial favourite with the god, and celebrated as a dancer, though a dwarf. Basava tells the king this story to shew the value and potency of faith.

A variety of other legends of miracles may be passed over; as deserving less notice than a dispute regarding the comparative potency of Siva and Krishna, who is the great god of the Bramins. The sermon against Krishna is delivered in the presence of the king by a Jangam named Bachi Devaiia.

Both Krishna, said he, and all the other gods are vastly inferior to Siva. For, were they really mighty how does it happen that they cannot

* See the prints in Moor's Hindu Pantheon.

vindicate themselves when misfortunes befal them? Neither Jainas nor Bauddhas worship the true god. Siva alone is supreme.

This book closes with a violent attack (in 400 lines of verse) on the adorers of Krishna (Vishnu) who is declared to be by their own confession not only a sinner but subject to degradation and death: "Vishnu was finally expelled from earth for his crimes and took refuge in the ocean." Siva is declared to be the supreme being, "one of whose servants would suffice to destroy Vishnu with all his adorers." At the close of this discourse, the prince (Bizzala) renounces the new braminical god (Gopala, or, Krishna) whom he had lately set up.

The seventh and last book (containing more than 2000 lines), describes the homage paid by Basava, as king's minister, to various *pariar** saints who adore Siva. The Bramins complain to the baron (Bizzala) of this conduct: and being summoned, Basava brings the pariar (sitting with him in his palankeen), to the palace. Being therefore excluded, Basava spreads his shawl at the gate and with his pariar friend seats himself on it. The king reproaches him for behaving in this manner, setting at defiance all the rules of caste: and expresses his apprehension that this may bring a curse on the land and heaven may withhold its rain.

Basava replies by telling some stories to prove that pariars are quite as good as Bramins, and that caste itself is a mere braminical device. He states that "the Vedas define but two castes, namely (*pravartica* and *nivartica*) the *active* and the *contemplative*. What avail *castes* recently instituted? Surely faith (bhacti) is the only point in which one man is superior to another. The Bramins here present are totally inferior to this pariar.

Then follow other extravagant stories wherein "the *dog* of a worshipper of Siva is declared as good as any worshipper of Vishnu"—Of a snake that dies as a punishment for biting a Jangam—Of a Jangam girl who considered herself defiled because touched by a Bramin woman: "because touching a Bramin would be a defilement even to the dogs of a Saivite's house. The Bramins are annoyed at being set below dogs,

* The word *Pariar* is originally Tamil, *parey*, plural *pareyer;* and signifies *a drummer* (from *parra*, a drum whence parrayan). For the pariahs hold the hereditary village employment of *Toty*, or *Vettiyaun:* answering to the Saxon villein, or serf and one of their stated duties is *to beat the drum* on public occasions. The Spaniards have used this Hindu phrase in South America: where they apply it to labourers and Indians: from Brazil too, they brought the word *peon* which there signifies either a foot soldier, household servant, or a labourer in general.

and affirm that at least a dog cannot read the vedas: a Jangam, however, desires his dog to try, and it succeeds very well.

Besides, Basava assures the baron that in many houses the dogs read the vedas quite as well as their masters. This is not impossible.

A zealot hears a man reading the legends in honour of Vishnu: but avoiding those which speak of Siva. Unable by argument to persuade the reader to do justice to his patron god, he killed him.

A woman who is a leper is driven out of the town by the Bramins: she attempts to visit a Siva temple: the god meets and heals her, and inflicts the leprosy on the Bramins. There follow many more miracles.

Basava's zealous exertions had now encouraged the Saivites to treat the Bramins and their temples with great neglect: and the king receives many complaints that the Jangams were gradually infringing on the rights of all other creeds. Some complaints are made by (boyas) herdsmen: who now lost the dinners (prasadam) which they (as cowherds) had hitherto been used to receive from those who formerly worshipped at the temple of Siva.

On being questioned regarding this by the prince, Basava declares that these men had a claim to the (prasad) blessed food bestowed at the Siva temples, but had no right to enter the houses of Jangams nor even to see their food. The claimants replied that at Casi, Gaya, and Prayaga (the sacred cities), they enjoyed this privilege: and therefore claimed it. He answered that they could claim nothing that is not *offered* at a Siva *temple*. "We of the Vira Saiva sect, he added, will not even tolerate the sight of a Saivite. But, said he, if you choose, you may dine with me to-day on poison; I shall be happy to see you."—The story ends in Basava eating the poison with impunity, through the power of (prasadam) the benediction which he utters over the food.

Bizzala then looks upon Basava as more mighty than Siva himself, as having swallowed the poison: whereas Siva does not venture to swallow the venom, and merely holds it in his throat. This alludes to a well known story regarding Siva.

On another occasion Basava is invited to dine in company with some Bramins and declines it: because he will not eat with those who neglect to bless the food in the name of Siva.

The next is a story about some cows which are faithful to Siva, and refuse food offered to them by any but Jangams: indeed, they will not eat until they behold the image and make an obeisance to it. "Thus a cow in the house of a devotee has more religion than a Saivite: then how can you be so brutish as to wash the feet of Bramins?"

Another devotee's wife bears him twins: he has provided only one image, which as usual, he hangs at the neck of the first born, and for want of a second he refuses to receive the second infant. This is applauded as a mark of great devotion.

Basava further says to the baron, "How can I convince you of the supremacy of Siva? it is as idle as teaching a blind man what light is. Your conduct is as foolish as using a golden plough, and then sowing thistles. Consider how unavailing were the sacrifices offered to Bramins by Gautama, by Dadhíchi, by Daxa, the emperor Bali and others No honours that you can offer to Bramins can in merit equal worship offered to the (lingam) image."

His friend *Jagad-Eca malla* is convinced of the folly of adoring Bramins, and offered his thanks to Basava: who now spoke to him in confidence, saying after a short time a dreadful crime will take place here: and you are to slay him who commits it: after which Siva will appear visibly to you.

There were two brothers named Allaiia and Madhupaiia constantly in attendance upon Basava: the baron (Bizzala) caused their eyes to be put out. but Basava and the other worthies restored their sight, after which they blotted out all the accounts kept in the royal treasury. They now sent for Jagadeca Malla, and told him that the appointed time was come for him to slay an offender. Basava now retired from the town, which was immediately filled with outrages, so much so that the devotees fled from it. Malla was appointed to put the baron Bizzala to death but went home without effecting this. His mother reproached him for failing to obey the command of Basava. She said, surely had they wished it the worthies were well able to do this themselves: they entrusted it to you merely as a favour conferred on you. If you disobey them I wish you may become a dog and live on (prasadam) rice given as alms.

Hereupon she treated him as a dog, and threw rice on the floor for him to eat. But the other worthies came to console him, and even ate what he left. They then led him to the palace of Bizzala whom these three men slew.* They then returned home, and Malla paid homage to his mother. Then remorse at the crime made them seek to kill themselves, but their god Siva appeared visibly and carried them all to Cailasa.

* This murder resembles the deed committed in the House of Commons on 30th Dec. 1654 (see Salmon's Chronological History), when a quaker wounded several people declaring that he was inspired to slay every man who sat in that house.

After the death of Bizzala,* Basava retired to the pagoda at Cudali Sangaweswaram, and prayed to Siva to take him to himself. Hereupon the god came out of the temple and appeared in visible form, and on being adored by Basava took him to himself (*aikyam*, unitedness, oneness, took place), while the people sung his praise: and thenceforward all the worthies adored Basava as being Siva himself.

The poet concludes by apologizing for the prosaic style in which he has recorded *the History of Basava.*

In a former essay, on the Jangams, it has been shewn that from local records the death of Bizzala appears to have occurred in the saca year 1090 or, A. D. 1168. Dr. Francis Buchanan, however, gives a more remote date (357 years earlier) to the events in question. He states that " in the year Vicrama (3875 of the Kaliyugam), Basava went with his sister to Kalyanam"—and specifies that this corresponds with A. D. 775; and " the time for Basava's remaining on earth terminated in the year Raxasa, 3911 of the Kaliyugam"—adding that this corresponds with A. D. 811: and that Basava's " absorption" or death took place on Wednesday the first of Margarisiras, at 21 hours (ghurries) of the night. Vide Buchanan's Journal in Mysore and Canara, 4to, vol. 3, p. 264.

But this author does not cite proofs of the dates thus minutely specified: and the later calculation (placing the death of Bizzala in A. D. 1168) is more likely to be correct.

Somia of Pidupādu (in his preface to his Padya version of the Puran) states that his ancestor, Somanatha of Palacurru, wrote the dwipada puran in the days of a prince named *Pratapa Rudra.* (This king according to Colonel Mackenzie reigned at Warangole from A. D. 1456 to 1477). And he adds that in those days the fear of the approaching Mahomedan rulers was prevalent. This agrees with the known period of the Mahomedan invasion of Warangole.† That puran is written by Somanatha in Telugu: it mentions no earlier poem: and is considered by the Jangams as their most ancient record.

The strong antipathy that exists between the Bramins and the Jan-

* It will be remembered that the *Jaina* account of this murder deviates in several important particulars: and probably is the true account. It is printed by Mr. Elliot in this Journal for 1838, page 212. The miraculous absorption of Basava's body is evidently meant to denote that he was not buried.

† See Briggs's Mahomedan Power in India, vol. 2, page 311, date of A. D. 1368 and page 448 of A. D. 1456.

gams makes each party avoid mentioning the authors respected by their opponents. This renders a comparison of dates far from easy. The Jaina chronologists mentioned in the former essay have perhaps recorded the true dates of the history: and the precise antiquity of the *puran* is interesting to those who cultivate Telugu literature; because the peculiarities of the dialect give reason to believe it the most ancient existing composition in the language.

POSTSCRIPT.

Those who wish well to the literature of India will hail with pleasure a notification which appears *in the Foreign Quarterly Review*, regarding a society now founded in London "for the advancement of Oriental Literature *by the publication of the Original Texts*." With the Earl of Munster as President, and Professor Wilson as Vice President, there is every prospect of its leading to results highly desirable. The *Devanagari* texts may be best published in Bengal or in Europe: that type being foreign to Southern India. But the Telugu, Canarese and Tamil printing (including Sanscrit publications in those alphabets) to be rapidly, cheaply, and correctly executed, should be ordered to be done at Madras and other towns, where we find an abundance of presses well supplied with the requisite types; and where there is no want of skilful compositors who are themselves natives.

As noticed in a former page of this Journal* it is much to be regretted that an ample collection of native literature, more than a thousand volumes, in the Telugu, Tamil and Canarese characters, should be removed from their proper sphere and lie useless in London; part being at the India House and part at the Royal Asiatic Society's Library; while at Madras we often are at a loss for the aid they might afford. In those museums I found some volumes (treated as mere curiosities) which if transferred to Madras might do solid service to Indian history and literature. Regarding remote times, the documents are not wanting: books of a date earlier than the Mahomedan invasion are easily found. But the bigotry of the Mahomedans and the indifference of the English rendered the survival of the more modern native literature precarious, and several works of merit may now depend (as did the writings of Phædrus) on a single manuscript. Because during these ages of neglect a volume however excellent, was but seldom transcrib-

* Madras Journal, No. 26, page 177.

ed; and some works have become as scarce as are the MSS. of Aristophanes. Some of these have found their way to England: and as a case in point there is a work (the Parama yoga Vilasam, in Telugu) of which I with much difficulty obtained one copy at Masulipatam: two others (incomplete) have with his usual kindness been transmitted to me by Professor Wilson: and another manuscript I discovered at Oxford in the Bodleian library, whence I yet hope to obtain permission to borrow it. I would willingly transmit a more legible copy along with it in returning the original, which if left to its fate will perhaps before long feast the worms.

VI.—*On the Structure of the Sevâlik Hills and the Organic Remains found in them.*—*By* Proby T. Cautley, Esq., *Capt. Bengal Artillery, F. G. S.**

The mountains, a part of which I am about to describe, range (with the exception of the debouchures of rivers) almost uninterruptedly from the Sutluj, which separates the territory of the British Government from that of the Sikh chieftain, Runjeet Sing, to the Burhampootur river, and the district of Cooch Behar. Their general bearing, in the portion near the Sutluj, is N. W. and S. E; but in that approaching the Burhampootur, it is many points nearer direct east and west. They lie at the foot of the great Himalayan chain, with which they are in some parts connected by a succession of low mountains; but in others, as in the districts under review, they are separated by valleys from three to ten miles in width, and called by the natives Deyra Dhoon, Kearda Dhoon, &c., or the Valley of Deyra, the Valley of Kearda, &c. The highest peaks do not far exceed 3000 feet, and the generality of the summits vary from 2000 to 2500 above the level of the sea. It is necessary, however, to premise, that my observations have not extended further eastward than the Ganges; and that whatever I may record, in this paper, beyond that river, is given on the authority of others.

Between the Ganges and Jumna rivers, this line of mountains is separated from the great chain of the Himalayas by the Dhoon, or valley of Deyra, the average width of which may be under ten miles. At the

* From the *Transactions of the Geological Society of London*, Second Series, vol. 5.

Ganges, or south-eastern extremity, a road passes between the chain and the river; and no difficulty whatever is offered to the approach to the valley. At the opposite or Jumna extremity, on the contrary, the mountains are in many places scarped into the river; and the footpath used by the boat and raft people, is an irregular track, over ridge and through hollow, and impinges upon the river at those points only where the stream, in its meandering course, strikes the opposite side of the channel. The intermediate roads, or ghàts, follow the rivers or hill-streams; for in such an utter confusion of mountains, any other passage is impossible. A few of these roads are passable for wheeled carriages, but the generality are bad footpaths. Between the Jumna and the Sutluj are two other valleys, the Kearda and the Pinjore, separated from each other by one of those complex masses of mountains which connect the lower with the upper Himalaya range. The hills are generally less precipitous in this neighbourhood; and the higher points and ridges are separated by valleys, affording a drainage to the country, and displaying on each side high and beautiful sections of the stratification These valleys, or plateaux—for, with reference to the rivers running below them, they may be considered as such—vary in width, but extend along the whole course of the mountain-streams.

As much confusion may be avoided, in the absence of a native name for the whole range of these mountains between the Sutluj and the Burhampootur, by establishing one, which may be considered legitimate, I wish to propose that of Sevâlik,* formerly applied to the portion be-

* In Smith's Exotic Botany, vol. i. p. 9., is the description of the *Rhododendron arboreum:* he refers it "to the mountainous tract called the Sewalic chain, which separates the plains of Hindostan, between 75° and 85° E. long. from the Himalaya mountains. I make the quotation for the value of the name, though the statement is evidently wrong; the rhododendron in question growing in the Himalayas themselves at a high elevation, and in company with oaks. The chain separating the plains of Hindostan from the Himalayas, which is the one now under review, is subject to a mean temperature perfectly inimical to oaks and the *Rhododendron arboreum.* The name is quoted also in Dow's History, and in some traditional writings in the possession of the high priest or Mahant residing at Deyra. The derivation supplied by the high priest is as follows:—

"Sewalik, a corruption of *Shibwalla,* a name given to the tract of mountains between the Jumna and the Ganges, from having been the residence of Ayshoor Shib, a name of Mahadeo and his son Gun, who, under the form of an elephant, had charge of the westerly portion, from the village of Doodhli to the Jumna; which portion is also called Gungujur (*gujur,* elephant): the portion eastward from Doodhli, or between that village and Hurdwar, is called Deodhar, from its being the especial residence of Deota, or Ayshoor Shib. The whole tract, however, between the Jumna and the Ganges, is called Shibwalla, or the habitation of Shib."

tween the Ganges and the Jumna; a name which appears to me better than that of the "Lower Hills" or the "Sub-Himalayan," terms, equally applicable to the subordinate ranges northwards of the Himalayas.

These preliminary observations will make the reader acquainted with the field of our fossil discoveries; and I proceed to the description of the geological features of the tract. The formations composing the hills, consist of beds of boulders or shingle, either loosely mixed or agglutinated by clay and carbonate of lime; of sands of various degrees of consistency; of marl or clay conglomerate;* and of an infinite variety of clays; the two latter being most extensively developed to the westward of the Jumna. The strata dip from 15 to 35 degrees, generally towards the north; and the breadth of the inclined beds is from six to eight miles.

The succession of the strata is irregular, with the exception of the shingle in the more northern tracts, where it appears to overlay as well as to alternate with the sandstones; whereas, although the debris is in considerable abundance in the water-courses, and on the flanks of the hills, I have never met with these shingle-beds south of the most northern half of the hills. A similar remark applies to the marl, but in a contrary direction, as it occurs only to the south. The want of the marl in the northern sections may be accounted for, by suppossing it to have been either a local deposition or a general one, which is not exposed throughout its entire range.

Although I consider the whole of this tract of mountain as composed of one formation, it may be of use to divide the portion between the Jumna and Ganges, from that westward of the former river, as it appears to me, that there is a marked difference (as before stated) in the shingle strata, as well as in the position and number of the clay beds; although perhaps nothing further than would be exhibited on any extended line of country, formed of debris from different tracts of mountains. The causes which upheaved this district, apparently acted more energetically in the contracted surface eastward of the Jumna, than in that to the westward; though, in the latter, the surface upheaved is much more extended. I shall therefore divide these notes into two

* I call this stratum clay-conglomerate, the beds being composed of fragments of an indurated clay, cemented together by clay, sand, and carbonate of lime; the clay itself effervescing strongly with acids. The rock is, in general, exceedingly hard and tough, as is shown in those parts where it is in contact with the stream of the rivers, which appear to have had little power upon it.

sections; the first consisting of the tract between the Jumna and Ganges; the second, that westward of the Jumna. To commence, therefore, with the range between the two rivers.

Hills between the Jumna and Ganges.

Shingle and Sandstone.—The beds of shingle are of enormous thickness, and alternate with the sandstone. The former precisely resemble the shingle in the beds of the existing great rivers of the country, and consist of boulders of granite, gneiss, mica slate, quartz, hornblende schist. and traps; and every other rock, through which these rivers hold their course. If the beds of the Jumna and Ganges were to be upheaved, in the same way as those of former rivers, the appearance of the strata would be exactly similar. The sandstone consists either of grains of pure quartz, with different proportions of mica, or of an admixture of the other ingredients so common in all river sands. The presence of oxyd of iron causes a great variety in colour, from red to gray, whilst the induration of the rock appears to depend on the proportion of carbonate of lime. In the more easterly limit opposite Hurdwar, as well as other places, the stone is quarried for building; and in many localities where it is crystalline, it is highly valuable in architecture. On the Jumna are the remains of an ancient hunting palace, built by the emperor Shah Juhan at the end of the 17th century; and although now in utter ruin, amongst its fragments are capitals of columns, and scolloped arch work, &c. cut in this sandstone, which prove it to be well adapted for architectural purposes. It is easily worked, and the mixture of mica gives two splitting surfaces. On exposure to weather, however, it exfoliates and crumbles, as is conspicuously shown in some lintels, still in position at Badshahmuhul. The colours of the clays are endless; and a light blue variety, which is found under the marl, as well as higher up in the series, where it contains fresh-water shells, is exceedingly pure. The strata of this blue clay are thin, but those of the other varieties are of all dimensions.

Lignite.—Carbonaceous matter occurs throughout the sandstones, either in detached fragments exhibiting vegetable origin, or in strata or seams composed of sandstone and lignite in equal proportions. Lignite is also found in the marl, but generally in the form of black dust; leaving, on its removal, an indistinct, vegetable impression. In one instance, I also met with it in the shingle strata. It has never been found in sufficient abundance to excite an inquiry as to its adaptation for œconomical purposes; though it is common to the whole of this tract of mountains.

Eastward of the Ganges it has been found, to the north of the Moradabad district; and it agrees in every respect with that found elsewhere. It has also been met with at points still more easterly; but the examination of that tract has been very slight. The most interesting point at which I have found lignite, is at the mouth of the Kalowala Pass, one of the entrances into the Deyra Dhoon, from the plains. A stratum or bed of yellow and red sand, about 18 inches thick, is there completely charged with lignite, either in long flattened masses, or in transverse sections of trunks of trees, which show, by their elliptical form, effects of vertical pressure. The lignite, in these cases, constitutes merely the outer covering; the interior of the trunk being composed of the sandstone matrix. The bed is enveloped in strata of the marl, abounding in the remains of animals; and both the lignite bed and the marl, appear at this point most distinctly to have been deposited in a hollow; the beds, at their lateral extremities gradually attenuating, until they meet the sandstone rock; and the lower surface being concave. Although the marl is evidently limited at this spot, it seems to exist so generally in extended strata, that, supposing it to have formed tracts of marsh land, those tracts must have been very extensive. I have before remarked, that I have seen the marl only on the southern limits of these hills, between the Jumna and Ganges. In crossing the former river, however, the same stratum, with the same organic remains, is met with on the north of the mountain ridge, on which the town of Nahun stands. Here the upheavement has been more violent than elsewhere; and the point of junction of this tract with the higher Himalayas is consequently much dislocated. It is necessary to state, that there are appearances of trap* in the neighbourhood of these disturbances; a fact which may lead hereafter to an interesting geological disquisition on the point of junction. Fossil wood, apparently *dicotyledonous*, abounds in the sandstone The woody fibre is generally perfect, but impregnated with the sandstone, and frequently mixed with carbonaceous matter; in which case the fossil is black, and on fracture has the appearance of an intimate mixture of coal and sand, or of an imperfect coal. The only remains of animals yet found are fragments of tortoises.

Marl, with Organic Remains.—As the marl is in greatest abundance in this section, I will now give an account of its organic remains; confining myself to classes and genera. These fossils are in appearance perfect, and the deep black colour which they have derived from hy-

* Dr. Falconer has made the same observation. Journ. Asiatic Soc. Bengal, vol. iv. p. 50; date of communication, 3d January 1835.

drate of iron, renders them ornamental. The medullary cavities are, in many cases, filled with pyrites, and in others with pure white crystallized carbonate of lime. The greater part of the fossils, already procured, is from the deposit in the Kalowala Pass; and as my collection is not only large, but abundant in different genera, the number already found in such a limited space, indicates the great variety of animal remains, which a diligent and extensive search may produce. Teeth, and the more solid part of the bones, are found in the greatest quantity. Most of the former are perfect, and as sharp in their outline as when the animals existed; and even in the fragments, the sharpness of the fracture proves, that they were quietly deposited in the sediment in which they are found. The following is a list of the fossils already discovered in the marl:—

MAMMALIA.

Pachydermata..... Teeth, and the remains of a species of *Anthracotherium*.

Carnivora...........Genera doubtful; but some of the teeth correspond with the third incisor of the bear.

Rodentia.............Rat, and a small variety of castor.

Ruminantia..... ...Deer, several varieties, and one molar of a very small species.

Solipeda..........Horse, one incisor, and one molar from the right side of the upper jaw: they exhibit a peculiarity in the form of the enamel flexures.

REPTILIA.

Crocodilia............*Ghariál.* (*Gavial* of naturalists.) Teeth and bones in abundance.

Crocodile. Teeth, in great abundance, fragments of the osseous plates, vertebræ, and other bones.

Chelonia.......... .*Emys.* Fragments of the plates of the back very perfect; also ribs, with the attached osseous part of the buckler.

Tryonix. Ditto, ditto. Some marked differences in the form and position of the rugous surface of the fragments of the buckler, may hereafter point out a variety of species.

PISCES.

Vertebræ and Scales—The latter doubtful.

TESTACEA.

Bivalve................Imperfect, but resembling *Unio.* *Univalve :* a cast resembling that of the *Paludina* of the present fresh-water.*

Besides these more easily determinable remains, there have been found a number of incisor teeth, which I cannot assign to any genus; also quantities of bones, in fragments, and portions of ribs, one of which must have belonged to a large animal; also vertebræ, matatarsal or carpal bones, &c. With the exception of the teeth, the remains are generally in fragments, and separated; nor does it appear probable that we shall meet with anything approaching to a complete skeleton.

In the tract then between the Jumna and Ganges, the fossil remains as yet discovered are thus disposed:—

Shingle, or Gravel Beds—Lignite, scarce.

Sandstone ....Trunks of dicotyledonous trees in great abundance; lignite, and remains of reptiles.

Marl.......................Remains of mammafers, reptiles, fishes, shells, and lignite.

The mineral products are, carbonate of lime, the general cement of the whole formation, also in stalactites and stalagmites; selenite, in small tabular crystals; and pyrites, but apparently in the neighbourhood of organic remains only. Soda abounds throughout the mountains, efflorescing on the shingle and sandstone rocks; and the presence of this alkali may explain the partial disintegration of the boulders of which the shingle is composed: for, I believe, I am right in asserting, that every variety of boulder, from granite to quartz and sandstones, has been acted on: and when it happens that the boulders can be removed entire from the bed, they fall to pieces, either after exposure to the air for a time, or by pressure of the hand immediately. With regard to fractures in some of the boulders, and their consolidation on different planes, as in a slip of stratification, no remark whatever appears requisite, as these are the necessary consequences of that movement, which raised the beds from their horizontal position. There does not appear to be any further remark necessary on this tract, more than can be reserved for the general summary; I shall therefore proceed to describe the hills westward of the Jumna.

* The only univalve which has been yet found in the marl is the cast above-mentioned, from the rock north of Nahun. I have entered it here, considering, as I do, that the deposits are identical.

Hills West of the Jumna.

These, as I before stated, consist of the same series of shingle, sand, clays, and marls; but they differ, in the beds of shingle being less abundant, although equally inclined, and in containing a different description of boulder. The rolled fragments eastward of the Jumna are all of primary or lower rocks, whilst those to the westward are confined to varieties of clay slate, and quartz. The marl, which, between the Jumna and Ganges shows itself in the southern limits, is here exposed at a point north of Nahun, cropping out on the northern slope of the mountain; and the fossil remains resemble those found in the marl eastward of the Jumna, consisting of mammafers, crocodiles, tortoises, fishes, and shells. From Nahun to the plains there is a succession of sandstones and clays, without any abundance of shingle. The sandstone, which, in the vicinity of Nahun, is much indurated, and used for building, becomes softer on approaching the plains; long before reaching which, the whole formation consists of an interminable succession of sandstones and clays, the latter being in the greatest abundance, of every variety of colour, and dipping, on an average, 20° to the north. The topographical outline of these mountains, shows a considerable southing of upheavement, in the hills westward of the Jumna: and the circumstance of the fossil remains abounding in the sandstones and clays in this tract, and not in that between the Jumna and the Ganges, may probably be due to the non-upheavement of the line on its prolongation eastward of the Jumna. The action, in all probability, was exerted irregularly; and although in the large scale we may lay down the dip and direction with accuracy, the former as varying from 15° to 35°, and the latter from N. E. to S. W., local details give very different results.

The sandstone rock, from which the fossil remains sent to the Society's Museum were extracted, reposes at the above angle, over numberless beds of clays, more or less rich in testaceous remains. The fossil bones lie in great abundance on the surface of the slopes in the neighbourhood of the sandstone, amongst the ruins of fallen cliffs, in the beds of water-courses, &c. The bones which we have had the good fortune to dig out of the rock are perfectly sharp, and in all their original perfection. I may here advert to a circumstance to which the preservation of the water-worn specimens is chiefly due. The sandstone is generally soft, but in the proximity of the fossils it becomes ferruginous, concretionary, and so hard as to turn the edge of the chisel; and thus protects the fossil from destruction in its progress, as a boulder along the torrent's bed. These concretions are occasionally globular,

and become singularly conspicuous, by the weathering of some of the ridges, when the mass of rock takes the appearance of huge spherical concretions piled confusedly on each other.

The organic remains of this sandstone yet brought to light, belong to the following classes and genera: most of the species are new; and the appearance of totally undescribed forms will add very considerably to our fossil genera. The new genera themselves will be the subject of separate accounts in their proper place.

Mammalia.

Pachydermata...Mastodon—elephant—rhinoceros—hippopotamus—hog.
Carnivora ... ...Canine and feline.
Ruminantia... ...Elk—ox—deer in great varieties.
Solipeda... ... ...Horse.

Reptilia.

Crocodilia........Gharial—crocodile; both very closely corresponding with the existing species now in the rivers. Lacertine remains indeterminable.

Chelonia.......Emys and tryonix; some of the fragments are of the most gigantic proportions. Of the smaller varieties, nearly entire specimens have been found; upper buckler and carapax complete. My cabinet also contains three heads, wanting only the occipital portion of the cranium.

Pisces.

Genera not established.

Many other fragments have been found, but so imperfect as to render a classification impossible. I may remark, that there appears to be no end to the variety as well as quantity of these remains; and we may expect to do much, even in this remote region, in advancing the inquiries respecting fossil zoology.

Of each genus above mentioned, with the exception of the horse and the carnivora, I have already almost perfect skulls. The bones of the body, however, appear to have been much broken and mutilated; but it is a singular fact, that from many places where the fossils have been found as mere debris of fallen cliffs, fragments of bone have been obtained, which have admitted of being joined, although the fractured ends were coated with carbonate of lime, as if they had been fossilized separately. A beautiful example of this, is exhibited in an almost perfect

rib of an elephant or mastodon, which is forwarded to the Society's Museum, and which consisted of no less than eight pieces. A perfect humerus of a ruminant has been secured in this state; and the bones of two hind legs, namely, the upper part of the metatarsal connected to the lower portion of the tibia by the intermediate tarsal bones, with, also, the os calcis entire, and all the smaller bones of the tarsus equally so. These remains have belonged to an enormous animal, and, I believe, to the same genus as that of a skull in my possession, and now under description by my friend Dr. Hugh Falconer, of the Bengal medical service, and myself. Although I refrain from zoological details, I must mention, that we have an animal evidently forming a connecting link between the *Pachydermata* and *Ruminantia*, or between the *Tapir* or *Palæotherium*, and the latter order of mammalia. The hippopotamus of this sandstone appears to be a new species, having six incisive teeth, besides other peculiarities, particularly in the proportion of the bones of the head: the tusks also differ from those described by Cuvier in his Ossemens Fossiles. The great depth at which the marl lies beneath the upper strata, with the discovery in it of remains of the horse, is an interesting fact. In the sandstone strata the remains of the horse are by no means scarce. There appears, however, to be a local disposition in the deposits of these remains. In some places the hippopotamus, elephant, mastodon, crocodile, tortoise, &c., are found in abundance, with the remains of ruminants; in others the hippopotamus and the water reptiles are almost totally absent, and only the remains of ruminants and carnivora occur; all tending to prove that these animals were destroyed on the site of their habitats; and that this former world was not more mysterious than the present; that there were vast tracts of marsh and river, with their attendant hippopotami and crocodiles in the waters, and elephants and mastodons in the neighbourhood; and that there were other tracts free from water and marsh, and frequented by their natural inhabitants, ruminants, carnivora, &c.

Dr. Falconer, in a note read at a meeting of the Asiatic Society of Calcutta*, suggested the identity of this deposit with that near Prome, some of the fossils from which have been so beautifully lithographed in the Society's Transactions†. The mastodons in the Sevâlik strata are in great abundance; and as we have perfect skulls, we are enabled to form some opinion of the dentition and the change of teeth. Three of these skulls, now in my cabinet, have the front tooth worn, and the rear

* Journal Asiatic Society, vol. iv. p. 58; date of communication, 3d January 1835.

† Geological Transactions, 2nd Series, vol. iii. p.377 *et. seq.*; pl. 36 to 43.

one coming into use; the whole line of teeth stretching on a surface of 19 inches, and forming an arc of 90°. The *front* tooth I cannot distinguish from that of the *M. Latidens* figured in the Geological Transactions; and the *rear* one, in the same animal, bears such perfect resemblance to the *M. Elephantoïdes*, that I cannot help risking the conjecture that the *M. Latidens* and the *M. Elephantoïdes* are one and the same animal; the specimens, from which the specific characters were taken, having been detached teeth.

Bringing this forward in the way of suggestion may be of use, in ultimately leading to truth. The question, however, must be determined by a strict examination of specimens; and having advanced the above supposition, I will take care that the means shall be provided.*

The minerals in this tract, west of the Jumna, correspond with those to the eastward, with the exception of the presence of the gold, which occurs in the beds of the rivers in these mountains, both eastward of the Ganges, and westward of the Jumna; but I am not aware of its existence in the intermediate tract. Under Nahun, gold-washers are constantly employed during the dry months; their daily return varying from two annas to two rupees, or from 3*d.* to 4*s.* The process is extremely rude. A piece of board, a long wooden trough, a ladle made out of a gourd, a sieve of the large grass which grows so abundantly in this part of the country, and a piece of hollow bamboo with a little quicksilver, constitute the portable apparatus of these most primitive washers for the precious metal.† A great deal of the gold-dust must necessarily be lost by this method of proceeding; and all the mercury, as it is evaporated in open air. The grains of gold are not larger than the small scales of mica, so common in river sand; and I have not heard that the metal has been found in large masses. This gold, too, has its localities, some streams being much richer than others. Where is the fountain head?

* The rear or newly-formed teeth of every species of mastodon resemble those of the elephant, so far as relates to the integrity of the apices or summits of their transverse ridges; and they might therefore be mistaken for those of the *M. Elephantoïdes*; but the observations which led to the conclusion, that the Ava specimens of mastodon belonged to two distinct species, were not made on detached teeth. A repeated examination of the jaws and teeth described by Mr. Clift, and the knowledge that his opinion was formed from considering the size and number of the transverse ridges in relation to the length and breadth of the teeth, have tended to confirm my belief in the establishment of two species, which I must retain until further and more definite evidence to the contrary is adduced.—Referee.

† See further particulars of the gold-washings in the Gûmté river, by Capt. Cautley, Journal Asiatic Society of Bengal, vol. iv. p. 279; Plate VII.; April, 1835.

In some stratum of this alluvium, perhaps, yet to be discovered, as the streams have no connexion with the higher mountains. A description of the washers , and the method practised by them eastward of the Ganges, have been given in the Journal of the Asiatic Society ; and as there is little difference in the apparatus used at both places, it is not necessary to refer to it further.

Some of the fossils obtained by Mr. Colebrooke in the hills near Cooch Behar, and described by Mr. Pentland*, are identical with some of those obtained by the present discovery ; and as the former were found in the most eastern extremity of this line, it is possible that a careful examination would prove the existence of animal remains throughout the whole of the intermediate mountains ; all the tract being probably tertiary. An inquiry into the difference between the hills bounded by the Ganges and Jumna, and those westward of the latter ; and into the confused and interminable dislocations, without any flats in the former, and the more scattered ridges with the intermediate plateaux of the latter, would only lead to a disquisition on the general formation of the dhoons or valleys lying between the Sevâlik hills and the great chain, which the limits of this communication will not admit, and must be left for future inquiry. It will be sufficient to state, that the general form of the mountains approaches more or less to a right angle, the long slope being covered with vegetation, and the crest terminating in a perpendicular and generally mural cliff, which descends into the beds of the torrents. The scenery from these cliffs is most picturesque, and many of the passes or ghàts up the torrents are bounded by gigantic walls of sandstone, varying both in height and character, and subject to all the tortuosities dependent on a river's course, forcing its channel through a complication of mountains. This effect is considerably heightened by the pointed and jagged style of the outline, depending on that abundance of clay and carbonate of lime throughout the whole formation, which permits even the shingle-beds to hold up their pointed summits in the wildest manner imaginable. At places, a perfectly inaccessible needle of shingle raises its head far above the others, and is crowned by one solitary fir tree, *Pinus longifolia.* This conical form, produced in the clays by weathering, is sometimes magnificently displayed, by the whole face of a cliff, consisting of light pink, yellow, and blue clays, being externally decorated with small conical spires of the clay from top to bottom, a height of 1000 feet from the bed of the river. The origin of this structure is due simply to a little coping stone, of some harder material than the

* Geological Transactions, Second Series, vol. iii. p. 393 ; Plate XLV.

matrix of the strata, and upon which the weather does not act so rapidly as upon the clay. Under a bright sun, the beauty of these cliffs, with their illumined pinnacles, is exquisite; particularly westward of the Jumna. I have before adverted to the presence of great abundance of lime, forming stalactites, and the cement of the sandstone and conglomerate. There is another striking method of deposition on the surface of the large stones which lie in the beds of the rivers, and which, during the greater part of the year, are in contact with the water. The substance is very similar in appearance to the coarse brown paper made in this country; and is produced by the water, while washing the stone, depositing its lime, and entangling the finer particles of vegetable matter, sand and mica, until the stone acquires a superficial coating, of a brownish yellow colour, which on removal resembles the substance before mentioned.

Note by the Editor Geol. Trans.

For detailed descriptions, by Capt. Cautley, Dr. Falconer, Lieut. Baker, and others, of the most important animals found in the Sevâlic Hills, see Asiatic Researches; Calcutta, 1836; vol. xix. Part. I.; and Journal of the Asiatic Society of Bengal, No 35. vol. iii. p. 527; Nos. 45, 46, and 48. vol. iv. pp. 495, 565, 706.; Nos. 49, 53, 55, 57, 58, 59, 60. vol. v. pp. 38, 291, 294, 486, 579, 661, 739, 768.

VII.—*Notice on the Remains of a Fossil Monkey from the Tertiary Strata of the Sewalik Hills in the North of Hindoostan.**—*By Capt.* P. T. Cautley, *F. G. S., Bengal Artillery; and* H. Falconer, Esq., *M. D., Bengal Medical Service.*

The most highly organized mammifers hitherto described in a fossil state, so far as our information extends, belonged to the *Cheiroptera;* and the instances of these on record are very few.† That quadrumanous remains should be wanting is by no means surprising, without the necessity of supposing that they did not exist. The countries of which the ancient races have been most completely investigated, had a climate unsuited to be the habitat of the tribe, as we now know it, when the

* From the *Transactions of the Geological Society of London*, Second Series, vol. 5.

† Brewster's Edinburgh Journal of Science.

more recent or superficial deposits were in progress of formation. If we refer to the remote epochs when the climate was suitable, and when genera now associated with the Monkeys were abundant, it is easy to conceive that the latter might have existed in numbers, without their remains being entombed. It requires in all instances many unconnected circumstances for the preservation of organic bodies, and their subsequent disclosure. Amongst the most important of these are the habits and organization of the animals themselves. As in the case of birds, it might be predicated, that this lucky concurrence of circumstances would be rare with quadrumanous remains. The very perfection in the organization of the Monkey entails, as a consequence, that his solid frame should seldom continue to indicate the previous existence of the individual. His admirable agility and social habits protect him against most aggressions. A flood might suffocate in their dens, over a large tract of country, the burrowing tribes; and might sweep from under the feet of the monkey hundreds of its herbivorous and predaceous fellow-tenants of the forest, and bury them in the near shingle or far-distant estuary, or drown and deposit them in the stagnant swamp—while he would remain secure. The tree on which he was perched might totter, and yield to the undermining current, and he still escape and feed on his wonted fruits, undisturbed by the destruction around. When the debt of nature comes to be paid, his carcase falls to the ground, and immediately becomes the prey of the numerous predaceous scavengers of torrid regions, the Hyæna, the Chacal, and the Wolf. So speedily does this occur, that in India, where Monkeys occupy, in large societies, mango groves around villages, unmolested and cherished by man, the traces of casualties among them are so rarely seen, that the simple Hindoo believes that they bury their dead by night.

When the ancient races of India began to open upon us in the new forms and the exuberant variety which the fossils of the Sewalik Hills exhibit, we were early led to anticipate that some trace of quadrumanous animals would soon be met with to perfect a series, which would be incomplete without them. Several months ago we became possessed of a solitary specimen, which put the matter, in our own minds, beyond all doubt. We deferred making it public, however, in the hope of soon finding specimens of the cranium and teeth; being unwilling to rest the announcement on any thing less characteristic. That chance has since fallen to our fellow-labourers in the pursuit, Messrs. Baker and Durand, of the Bengal Engineers, who have lately discovered a specimen, consisting of a considerable portion of the face, and the whole series of molars

of one side, of a quadrumanous animal belonging to a much larger species than the bone we found.

Our fossil is the specimen which accompanies this communication. It is the astragalus of a right hind leg. It is completely mineralized, having a specific gravity of about 2·8, and it appears to be impregnated with hydrate of iron. Although but a solitary bone of the foot, the relations of structure are so fixed that the identity of the fossil is as certain as if the entire skeleton were before us. The very shallow excavation of the superior surface for the pulley-like articulation with the tibia; the form and extent of the lateral articulating surfaces for the external and internal malleoli; the considerable elongation of the apophysis for the head and neck of the bone; the slight obliquity with which it is sent off from the body; and the diagonal direction and form of the principal articulating surface with the calcaneum, are characters which, taken in conjunction, incontestably prove that the fossil is a quadrumanous astragalus. It would be needless, therefore, to dwell on the points of difference between it and the astragali of those orders of Mammalia which have an allied form. It is only requisite to ascertain how it agrees with the corresponding bone in existing species of Quadrumana. It closely resembles, in size and general form, the astragalus of the *Semnopithecus Entellus*, which we send along with the fossil for comparison.

The principal dimensions are as follow:—

Dimentions.	Sewalik Fossil Monkey.	*Semnopithecus Entellus.*
Extreme length of astragalus	1·3 inch.	1·35 inch.
Extreme width of body of astragalus	1· ——	1·03 ——
Length of body	0·8 ——	0·85 ——
Greatest diameter of navicular head	0·65 ——	0·65 ——
Thickness of ditto	0·45 ——	0·5 ——

The chief peculiarities of the fossil astragalus, compared with that of the Entellus, are these:—The upper articulating surface for the tibia is more convex than in the Entellus, and less square in the outline, the lateral margins approximating as they run backwards; the outer one being also more elevated. The peroneal articulation is precisely of the same form and extent as in the Entellus; and the rough fossa between it and the large calcanean surface also corresponds. The articular surface for the inner malleolus somewhat differs: in the fossil it is long, shallow, and rather pyriform in outline, while in the Entellus it is cup-shaped, deeper, and more extensive. The other pits and inequalities of the inner side correspond; but the entire surface slopes off more obliquely in the fossil. The great calcanean surface has the same

diagonal direction, with reference to the upper surface, as in the Entellus: it has also the same form, but it is more vaulted, and has less stretch and width. Its inner margin is bounded by the shallow, pulley-shaped fossa for the tendon of the *flexor pollicis longus* muscle, entirely as in the Entellus; and the rough pit between it and the anterior calcanean surface is alike in both. The head-and-neck apophysis is sent off as in the Entellus. The upper surface of the neck is narrower and less sloped. The scaphoid surface of the head is altogether less extensive. The head itself is not so thick and massive, and its long direction slopes more obliquely upwards than in the Entellus; its inferior articular surface is less, and there is a wide, rectagonal, rough gutter or fossa running half way across, so as to make two surfaces. In the Entellus the fossa is obsolete, and only indicated by a minute foramen, so that these articular surfaces run into one. This is the greatest difference observable in the fossil. The rough fossa at the outer side of the neck is alike in both.

With these inconsiderable peculiarities, the fossil agrees so closely in size and general form with the astragalus of the Entellus, that it probably belonged to the same sub-genus: still the points of difference are sufficient to leave no doubt, that the fossil must be assigned to a distinct species. In equalling the Entellus, it would belong to the larger Quadrumana. This is all the information the specimen conveys, regarding the animal from which it came; but we may hope to meet with remains, which will develope its entire osteology, more especially that of the cranium and face. The fossil was found by a party of Hindoo collectors employed by us on the fossil tract of the Sewalik Hills; and was brought to us mixed up with a promiscuous collection of the remains of the Hippopotamus, Mastodon, Ruminants, &c., like the specimens which have been sent to the Society. We have not therefore the means of knowing the exact locality where, and the circumstances under which, it was found.

The discovery is interesting in itself as supplying a deficient link in the series of the former tenants of the globe; but greatly more so in connexion with the races with which the fossil was associated. We have excavated from, or found in the debris of, different beds of the same formation which yielded the fossil astragalus, the remains of a species of Anoplotherium,* the *Crocodilus biporcatus* and *C.* (*Leptorhynchus*)

* *Anoplotherium Sivalense*, a new species, of a size somewhat larger than the *A. commune* of the Paris basin. The species is known to us by two upper jaws in our possession with the series of molars complete. We therefore quote it unhesitatingly.

Gangeticus,* respectively the Magar and Gavial, two species which at the present day inhabit the quiet waters of the Ganges. Here then are two most instructive facts: Quadrumana co-existed with a member of the oldest ascertained pachydermatous genus of Europe; and two reptiles now the contemporaries of man in the East, lived, and may have laved, in the same waters along with a species of one of the mammiferous genera which characterise the Eocene period of the West;—affording another illustration of constancy in the order of nature, of an identity of condition in the earth of the olden time with what it exhibits now, and of the invariableness of organized forms. The two decurrent ridges on the face which specifically distinguish the *C. biporcatus* of the present day, are as marked and distinct on the individuals which existed perhaps centuries of centuries ago; and an ankle bone of the Sewalik fossil Monkey so closely resembles that of a living species, that it is difficult to explain the difference.

The Sewalik fossils abound in monuments of this sort. There is a mixture of the new and of the old, of the past and of the present, of familiar with surprising forms, together with a numerical richness, such as no other explored region has exhibited within so comparatively limited a space. The Camel,† the Antelope, and Anoplotherium, have been found, intermixed with each other in the *same bed*. There are remains of the Elephant, Mastodon, Hippopotamus‡, Anthracotherium, Rhinoceros§, Hog, and Horse; the Tapir alone of the large existing Pachydermata being without a representative. In the Sivatherium|| is seen a huge Ruminant exceeding in size the largest Rhinoceros; it is also armed with four enormous sheathed horns, divided and foliated like the Dicranocerine Antelopes, and able to contend for mastery with the Mastodon. Contrasted with him in the same family is the puny

* Known to us by specimens comprising the whole of the cranium and muzzle. They do not differ more from the existing individuals than these do from one another in varieties dependent on age and sex. Asiatic Researches, Vol. xix. Part II., Art. II.

† *Camelus Sivalensis* (Nob.), Asiatic Researches, Vol. xix. Part II., Art. X., a species of the size of the existing Camel.

‡ Asiatic Res., Art. III. *Hippopotamus Sivalensis* (Nob. & *H. dissimilis*, Nob.).

§ Journal of the Asiatic Society, Vol. iv. p. 706, and vol. v. p. 486.

|| Asiatic Research. *ut supra*, Art. I. *Sivatherium Giganteum* (Nob.). Since the memoir was printed, Col. Colvin, Bengal Engineers, has got a specimen of the cranium with the bases of the four horns attached, and we have in our possession an almost entire rear horn, which has given the characters noted above.

Musk Deer, scarcely larger than a Hare. There are the Cat* and the Dog tribe, the Hyæna, Bear†, and Ratel‡, and other Carnivora. In the feathered races, there are Grallæ, greatly surpassing in size the Gigantic Crane of Bengal (*Ciconia Argala*). Among the Reptilia, besides the Magar and Gavial, there were other Crocodiles§ of enormous bulk, approaching the largest Saurians; and the Testudinata, which have hitherto held but a humble rank beside their Saurian co-ordinals, here show their giant representatives. In addition to numerous species of Emys and Trionyx not bigger than the small Terrapins of the sluggish brooks of Hindoostan, we possess humeri and femora of this tribe (with corresponding fragments of the bucklers) as large as the equivalent bones of the Indian Rhinoceros. As the Pterodactyle more than realized the most extravagant idea of the Winged Dragon, so does this huge Tortoise come up to the lofty conceptions of Hindoo mythology: and could we but recall the monsters to life, it were not difficult to imagine an Elephant supported on its back.

VIII.—*Memoir on the Geology of Cutch.*‖—*By* C. W. Grant, Esq., *Capt. Bombay Engineers.*

Geographical Position, and Physical Aspect.

The province of Cutch, in the East Indies, is situated between the 22° and 24° of north latitude, and 68° and 70° of east longitude. It is bounded to the north by the Grand Runn, beyond which is the Thur or Little Desert; to the S. W. and S. by the Gulf of Cutch and the Indian Ocean; to the E. and S.E. by the district of Guzerat; and to the N. W. by the eastern branch of the Indus and the territory of Sinde. Its extreme length from E. to W. is about 180 English miles, and its extreme breadth is 50 miles; but in one place it is not more than 15 miles across. It contains about 6500 square miles, independently of the

* Asiatic Researches, Art. XI. *Felis cristata* (Nob.). Smaller than the Tiger.

† *Ibid.* Art. XII. *Ursus Sivalensis* (Nob.). Size of the *U. Spelæus.*

‡ Messrs. Baker and Durand, Journal Asiatic Society, Vol. v. p. 581.

§ *C. Leptorhynchus crassidens* (Nob.), an immense species far exceeding existing ones, and forming a passage from the Gavials into the true Crocodiles. It has the cylindrical muzzle and synostorized lower jaw of the former with the blunt thick teeth of the latter.

‖ From the *Transactions of the Geological Society of London,* Second Series, Vol. v.

Grand Runn, which ought, however, to be considered as a part of the province, and which, including the islands with the portion bounded by the Guzerat coast, occupies an area of at least 9000 square miles.

Physical Aspect of the Country.—The province is hilly and rocky, with the exception of the part forming the southern coast, which is a dead flat covered with a fine rich soil. Three distinct ranges of hills, having an easterly and westerly direction, may be traced. The most northern forms an irregular chain bordering the Runn, and, for the greater part, presents to the north a perpendicular cliff surmounting a sloping talus, and to the south an inclined plane. It is composed chiefly of rocks, containing marine remains. The next, called the Charwar range, passes transversely through the centre of the province, and is connected with the former, at its north-western extremity, by a cluster of hills. It consists partly of sandstone containing beds of coal, and partly of a series of strata of slate clay, limestone slate, and slaty sandstone. The third, or southern range, and composed entirely of volcanic materials, has the same direction as the other two ; but it is of smaller extent, and a branch of it, striking nearly north and south, passes through the centre of the Charwar range. A number of isolated volcanic hills are also scattered over the plain and in other parts of the province, particularly on the borders of the Runn, where is situated the hill called Denodur, the largest in Cutch.

There are no constant streams, the river courses being merely channels for conveying the periodical floods to the sea, and containing, during the remainder of the year, only detached pools. The banks of these courses are, however, very high and precipitous, and afford excellent sections of the strata through which they pass.

Formations.

I have divided the country into the following eight distinct formations :—

1. Syenite and quartz rock.
2. Sandstone and clay, with beds of coal.
3. Red sandstone.—This formation I have been unable to trace the boundaries of. In mineralogical characters it resembles the new red sandstone of England, and differs materially from No. 2., or the formation which contains the coal.
4. Upper secondary formation, consisting of slate clay, limestone slate, and slaty sandstone, and containing *Ammonites*, with other fossils characteristic of the secondary formations of Europe.

5. Nummulitic limestone and marl.
6. Tertiary strata.
7. Alluvial, or recent deposits.
8. Volcanic and trappean rocks, including all such as bear evident marks of a perfectly igneous origin, as basalt, &c.

These eight divisions, considering the red sandstone as one, represent generally the geological structure of the province, though many minor subdivisions might doubtlessly be made.

1. Syenite and Quartz Rock.

The only good example of syenite *en masse* is a hill called Calunja, near the town of Nuggur in Parkur, a district in the Thur, and not far from the mouth of the Loonee river. It is not in Cutch Proper ; but as it forms part of the northern coast of the Runn, and is in other respects connected with the geology of the province, I have introduced it as one of the formations.

The Calunja hill is a confused heap of light red syenitic rocks, composed of quartz, red or white felspar, and large long crystals of hornblende ; the compound being sometimes coarsely grained, and sometimes finely. The base of the main hill is surrounded with small conical mounds, which, at a distance, resemble the huts of a village. On entering the space occupied by these mounds, the hill presents a number of irregular, shattered masses, the sides of which are so steep, and are worn so smooth by the action of the elements, as to be extremely difficult of access. Between these masses the sand lies very deep. It is quite evident, that this hill has been violently acted upon by earthquakes.

In the bed of a river near the village of Koonerea, in the Puchum island, situated in the Grand Runn, I found some masses of precisely similar syenite, which were probably erratic blocks from the Calunja hill ; this island lies nearly in the direction which would be taken by any sudden floods, coming down the Loonee river.

Quartz Rock.—This rock is principally developed in a hill of considerable height near the town of Mhurr, situated towards the western side of the province. The upper part of the hill is entirely composed of it, and huge masses are scattered about the base. A large cleft extends about half way up the western face of the hill, and displays its internal structure, consisting of a centre of quartz rock, surrounded by horizontal strata of loose, quartzose sandstone. The quartz rock varies considerably in character, being sometimes perfectly compact, exceedingly hard,

conchoidal in its fracture, and smooth or foliated on the surface; in other parts it is saccharoidal; occasionally it consists of larger particles, so firmly cemented together that they break with smooth surfaces: some masses, again, have a decidedly granular texture; and one variety is composed of rounded pebbles of quartz of the size of marbles; but in no specimen did I find any other material than pure quartz.

From the extremely fractured appearance of this hill, and from the quantities of basalt lying about, and forming the principal part of some small hills immediately adjoining it, there can be no doubt that it has been subjected to igneous influence; and to the same cause the variety in the texture of the quartz is also probably due, some portions appearing to have been sufficently fused, for its particles to have agglutinated into a solid mass. This opinion may perhaps be further strengthened by an examination of the country near the town of Mhurr, distant about one mile and a half, where various dykes of basalt traverse the strata. Similar intermixtures of quartz with basalt occur in a hill called Peaka, from its piebald appearance, not far from Joorun, on the Runn, and nearly opposite the south-west extremity of the Bunnee: also in some low hillocks at the base of the Katrore hill in the Charwar range. At the village of Ghuranee, about ten miles east of Mhurr, a large dyke or vein of quartz protrudes from a level plain, and forms a ridge of solid rock about 30 feet in height. Basalt also crops out near the same spot.

2. Sandstone and Clay, with Beds of Coal.

This formation occupies a considerable portion of the country, and consists of a regularly stratified series of thick beds of sandstone, alternating with slate-clay, which contains, occasionally, bands of ironstone; and where the coal occurs, it is intermixed with blue clay or shale, and a greasy substance resembling fullers'-earth. South of the Charwar range, the general dip of the strata is S. by W. and S. W., at about one foot in twenty or thirty; but north of that range, the dip varies so much, that it is impossible to ascertain the prevailing direction; and the whole series is so broken, and intersected with dykes and dislocations, as to render fruitless all attempts to determine its general strike.

The centre of the province is dotted with hills containing igneous rocks; and the disturbed state of the beds, in their vicinity, may easily be conceived. The smaller hills are composed of confused heaps of a very ferruginous sandstone and ironstone, belonging to this formation, and the surface soil is a deep sand. The

texture of the strata varies from a coarse, loose sandstone to a compact and extremely hard quartzose grit and conglomerate, cemented by ferruginous matter, some specimens being almost black.

Iron Ore.—In this formation, the iron ore smelted for commerce is procured. It is found in different parts of the country, but has been principally extracted near the town of Doodye, opposite the S. W. termination of the Bunnee. It there occurs in small lumps, which are of a spongiform texture, small specific gravity, and are very frangible. The natives, however, value this variety more than the heavier, from its yielding with greater ease to their imperfect means of smelting.

Manufacture of Iron.—In extracting the metal, layers of very small pieces are disposed alternately with others of charcoal, in a rude open furnace, and exposed to the blast of two small bellows made of sheepskins. The metal, when fused, falls into a hole at the bottom of the furnace, whence it is transferred to an inclosed furnace, and subjected to similar blasts, until brought to a white heat, when it is taken out and beaten into a bar. No flux of any kind is used. A considerable quantity of iron was, at one time, made from a totally different description of ore, found near the village of Punundrow, in a plain which extends to the sea or eastern mouth of the Indus. This plain is bounded to the south by low hills covered with fragments of basalt, being outliers of a basaltic range further to the south-east. The surface of the plain is composed of a fine smooth gravel, composed of comminuted particles of iron ore, and has every appearance of having been, at no distant period, covered with water. The iron ore is found near the surface of the low hills above mentioned, in small tabular fragments imbedded in a purple-coloured earth ; and those pieces are selected, which give a bright streak on being struck by a pointed instrument. Externally the ore is of a purple colour, and internally presents small dark blue fibres, arranged at right angles to the surface of the specimen. In another place a variety occurs, which resembles small fragments of tile, but has the same internal structure. It is very hard, and of considerable specific gravity ; and is said by the natives to have yielded a much greater per centage and much better iron than the ore found at Doodye ; but the manufacture of it has been suspended, owing partly to the scarcity of fuel, and partly to English iron being procured at a cheaper rate, as well as in much more convenient forms.

Coal.—Coal has been found in this formation in various places, but not in beds sufficiently thick to be worth working. It was first dis-

covered in the bank of a river near the city of Bhooj, forming a bed about 18 inches thick, and associated with strata of sandstone and blue clay, the dip being, to the eastward, one foot in twenty. This bed was worked for some time, and considerable quantities of its produce were sent to Bombay, but the quality was bad, being very slaty, and containing a large proportion of incombustible matter. Attempts were afterwards made to discover coal in other parts of the province; and although various beds were met with, they were too thin to be of any value. This search was carried on principally to the south of the Charwar range, a few miles from the town and fort of Seesaghud. One bed was found of a very good quality, but only 9 inches thick. It consisted of masses composed of small cubical pieces, which soiled the fingers very much, had not the slightest appearance of a lignite, and ignited quickly, burning with a bright flame, and leaving a small residuum, but it would not cake. It was found on trial to get up the steam of an engine-boiler very well and quickly, but a much larger quantity was required than of English coal, owing, partly, to its breaking into so small fragments as to fall through the bars of the grate.

Borings for Coal.—A boring for coal was made near this bed; and although 270 feet of sandstone and blue clay were penetrated, no coal was found. A similar attempt was made six miles further to the eastward, and to the depth of 191 feet, but with no better success; and similar researches were made in one or two other places. The second trial passed through a regularly alternating series of sandstone and blue clay. Some of the sandstones were so extremely hard (being composed of quartzose particles cemented by ferruginous matter) as to be almost impenetrable. A jumper, worked by a lever-bar, making eighteen strokes in a minute, penetrated, after eight hours' work only, from 1½ to 2 inches. Other specimens of sandstone varied both in hardness and quality; and at a depth of 190 feet, a bed of white, pure quartzose sand was entered, when water immediately rushed to the surface, and continued to flow in such quantities as to stop the work. The shale was of a very dark blue when first brought up, but it lost the greater part of its colour after exposure to the sun. Iron ore and iron pyrites were found. All the banks of the rivers in the neighbourhood present strata of sandstone and slate-clay, with bands of ironstone, and, in places, thin beds of coal. The general dip is, to the south-west, about one foot in twenty; but the strata are greatly shattered and dislocated by dykes, slips, and hitches.

Vegetable Impressions.—The slate-clay, and, in some cases, the sandstone, contained numerous impressions of ferns and reeds, occa-

sionally of a large size. One specimen, which was flattened, was four inches in breadth, and the outer surface was carbonised, but the interior was filled with sand: this was generally the case, though other specimens were carbonised throughout, and some were mere impressions. In digging wells within the limits in which they occur, coal was frequently found, but always in thin beds; and some of it ought more properly to be called lignite.

Extent of Coal-field.—The coal-field, if it may so be termed, is bounded to the north by the upper secondary or laminated slate-clay and limestone slate formation; and to the south it is cut off abruptly by a low range of volcanic and trap hills. I could not ascertain whether it had ever been covered by any conformable, stratified deposits. Thin beds of coal have been found in various other parts of the formation. The general structure of this series of strata, the quality of some of the coal, the nature of the sandstone and slate-clay, the impressions and remains of reeds, ferns, &c., the bands of ironstone, the dislocations by dykes, slips, &c., all bear an analogy to the coal-fields of England; but I am inclined, from the vegetable remains, to consider this deposit an equivalent of the oolitic coal of England, and not of the regular carboniferous system.

Alum Works near Mhurr.

The ground on which Mhurr is built, consists of high, irregular banks of marl of every variety of colour, but in a most confused and shattered state. It is surrounded on three sides by steep hills, forming a kind of amphitheatre; and nothing can be more desolate than its appearance. North of the town is a high table-land, which extends to some hills about one mile and a half distant. It is composed, near their base, of a ferruginous quartzose sandstone, on which the variegated marls rest; the latter being covered, in many places, with a bed of coarse gravelly detritus, six or eight feet thick. Imbedded in this gravel, are some very large masses of basalt, and of a very hard, black stone, composed of grains of quartz cemented by an almost black oxide. They are cut into mill-stones for grinding flour. The whole are evidently boulders from the hills to the northward, which were mentioned in the first part of this memoir, as consisting of quartz and basalt. This plain terminates, to the southward, in a high bank overlooking the town, and intersected in one part by a large dyke of spheroidal basalt, which has apparently so indurated the strata of variegated marl in its vicinity, as to permit them to be

quarried for building. A large quantity of alum is made at this place, and exported to different parts of India.

Manufacture.—The shale from which alum is obtained, forms beds in the variegated marl; and in a kind of blue clay. Long galleries are cut for the purpose of extracting it; but so plentiful is the supply, that no means are taken to support them, and they generally fall in during the rainy season. The manner in which the alum is prepared is very simple. The earth is exposed in heaps to the sun and air for about five months, during which it burns spontaneously. It is next laid out in little beds similar to those of a field prepared for irrigation, and it is watered by a small stream for ten or fifteen days, by which time the aluminous matter accumulates into semi-crystalline plates. This substance is boiled in water for about seven hours; after which, a third, or one half, by weight, of potash is added, and it is again boiled for a few hours, according to the strength of the ley. It is then poured into large open vessels, where, after settling for some time, it is washed, and the liquid drawn off, leaving an impure crystalline sediment. This is once more boiled, and when it arrives at a proper state, which is learned by practice, it is poured into large earthen vessels with a small mouth, and sunk into the ground to prevent their breaking. After a time, the vessels are dug out, broken to pieces, and a lump of pure alum extracted. Six or eight measures, by weight, of alum, are produced from ten measures of the substance from the irrigating beds, and four or five measures of potash. It is not so much esteemed in the Bombay market as that brought from China, on account of its yellow tinge.

Some of the marls resemble chalk, being white, and soiling the fingers; and some are very calcareous, whilst other varieties scarcely effervesce with diluted muriatic acid. In one mass I found a very minute specimen of *Buccinum pumilum.* These marls also occur of every variety of colour as well as texture; some of them consisting of innumerable thin laminæ curiously twisted and arranged in the most intricate manner; and others of a kind of breccia, composed of small broken portions of marls. Several dykes of basalt cut through these beds; the whole presenting a most confused assemblage, partly due to natural causes, and partly to the numerous mines which have fallen in. One of the banks has been burning spontaneously for several years, in a similar manner to that at Ruttrea, and apparently from the same cause. The exact geological position of these marls I could not determine.

3. Red Sandstone.

I have mentioned a red sandstone formation, which may be described now. It occurs to the southward of the coal series, and is separated from it by a low range of hills about six miles broad, composed partly of basaltic rocks, and partly of a variety of porphyry. This sandstone is regularly stratified, and has the same dip and inclination as the sandstone and coal series, but differs very materially from it, in being much softer, generally finer-grained, of a vast variety of colours, and by containing no organic remains. Associated with the sandstone are beds of clay, varying in colour from purple to deep red. One of the beds is aluminous, and has been burning spontaneously for a long period. The smoke issues from a deep crevice in the bank, and the fumes are highly sulphureous. A stick thrust into the crevice soon ignites, and the whole bank has a burnt appearance; the red clay, which rests immediately upon the stratum, having been converted into a perfect brick, and the other variegated clays having been variously acted on. Although this bed would yield a large per centage of sulphate of alumina, it has never been worked. The strata dip at an acute angle to the south, and are covered, in that direction, by beds of gravel, succeeded by others of sand and soil, which extend to the sea.

4. Laminated Series or Upper Secondary Formation.

Alternating strata of slate-clay, limestone-slate, and occasionally slaty sandstone, constitute this formation. The more calcareous beds are very hard and compact, whilst some of the others are very earthy and friable. In many of the calcareous slabs, the upper and under surfaces are argillaceous, hard, and compact, but the centre is a grey limestone, which takes a good polish, and might be used for lithography. The slate-clay is of a dark blue colour, and generally peels in thin flakes, leaving a flat, lenticular nodule or centre. In many places, vast thickness of this laminated slate-clay occur without the least admixture of the sandstone-slate, whilst in others, the latter alternates very often with it.

The beds being horizontal, except where they have been disturbed, the formation occupies considerable tracts; and where it rises into hills it is generally capped by a thick bed either of coarse, soft sandstone, as in the ghâts of the Charwar range, the Bhooda hill (near Bhooj), the Jarra (near the Indus), and other hills; or of a very compact, hard, crystalline sandstone, with a conchoidal fracture, as in the Chuppal hills, the Jarra, and in other places, including the natural walls of the Runn, described in a subsequent part.

Relative Position with respect to the other Strata.—I searched diligently to find the relative position of this formation distinctly defined, but in vain, as, at its apparent junction with other beds, the whole of the strata were broken up, and so confused as to baffle every attempt to ascertain the boundary. I am induced, however, to believe that it occupies hollows in the sandstone and coal formation, or abuts against it. It cannot underlie that series, because its strata are always *horizontal*, except where locally disturbed ; while the beds of sandstone and coal are as invariably inclined at a considerable angle, and are everywhere intersected with dykes, slips, and other dislocations, from which the upper secondary strata are generally free. In one instance the formation evidently occupied a hollow in the coal sandstone.

In many places it appears to abut against the sandstone, occupying large tracts which may, at some period, have been covered by beds of that formation, subsequently washed away. From what has been stated above, it is at all events newer than the coal beds ; and this conclusion is also borne out by its imbedded fossils.

Apparent Position with respect to the English Series.—In its mineralogical character and general appearance, this formation greatly resembles the English lias ; but its fossils have been found, after a careful examination by Mr. James Sowerby, to assimilate very closely to those of the oolitic beds ; and a very few belonging to the green sand.

Fossils.—Of the fossils found in these beds, the Ammonites are the most characteristic, occurring in vast quantities, particularly in some hills bordering the Runn. Of the eleven species which I collected, eight are unknown to Mr. James Sowerby, to whom I am entirely indebted for all my information regarding them. Of the other three species, one so closely agrees with *A. Herveyii* of the English cornbrash, that he is induced to consider it only a variety of that species ; another in the outer whorl resembles *A. perarmatus* of the coral rag, but differs in the structure of the inner whorls ; and the third, of which there is only one imperfect specimen, is like *A corrugatus* of the inferior oolite of England. They generally vary in diameter, from three to five inches : the largest I found being eight inches. It was imbedded in a mass of gold-coloured oolite. The genus next abundant is the Terebratula. Of the seven species collected by me, five bear so close an analogy to the *T. biplicata*, *T. dimidiata*, *T. sella*, *T. intermedia*, and *T. concinna* of the green sand and oolitic series, that it has been found impossible to consider them distinct species. The Trigonias are numerous, though con-

fined to two species, one of which differs so very little from *T. costata* of the lower oolites of England, that Mr. Sowerby considers it only a variety of that fossil. The genus *Pholadomya* also abounds, but the specimens are generally broken. Of the three species I collected, Mr. Sowerby has not been able to establish an identity with any known Pholadomya in England, although there is a general resemblance to the oolitic and lias fossils. I found two species of Belemnites, one of which resembles *B. canaliculatus* of the inferior oolite ; the other is not determinable. Of the species of oysters, one resembles the *Ostrea Marshii* of the English cornbrash. I found it in a bank high up the Katrore hill, in the Charwar range, in friable, laminated strata of slate-clay and sandstone slate, associated with Ammonites of the same description as those at Charee and along the Runn*. I did not find a single specimen of a Gryphæa, although numbers of the genus have been collected from this province. Some crinoidal stems, which I collected from the same localities resemble those of a species found in the mountain limestone ; but as the fossils above enumerated characterize the middle series of the English upper secondary rocks, fossils belonging to so much older a formation can hardly be associated with them. These crinoidal remains, therefore, probably belong to an undescribed species. The only fossil bone which I discovered, Messrs. Clift and Owen consider to be a caudal vertebra of a Saurian. This determination is, however, very interesting, as it shows how widely these animals were distributed; being, in this distant country, also associated with the same mollusca (one valve of a *Trigonia costata* is imbedded in the mass containing the bone) as accompany their remains in the English strata.

In the Appendix to this paper I have given a complete and systematic list of all these fossils, stating the localities where I collected them.

General Shape of the Hills belonging to this Formation.—Many of the hills in Cutch present, on the north side, a perpendicular cliff surmounting a sloping talus, and on the south an inclined plane ; and they owe this peculiar outline to their being composed of a base of laminated clay or sandstone, capped by a thick bed of coarse and brittle sandstone. This is particularly the case in the Jarra hill, and the hills of Hubbye, Lodye, and Roha-ké-Koss, near the village of Joorun, on the Runn ; also those of the Puchum and Khureer islands in the Runn, particularly the

* At the base of these hills, and forming the immediate borders of the Runn, fossil shells are found of a very different description, among which I may enumerate *Cardium*, *Pecten*, *Corbula*, *Venus*, *Globulus*, and vast quantities of *Turritella* ; which last form large masses of rock protruding every here and there above the bed of the Runn.

latter; likewise those near Beyla, at the north-eastern extremity of the province, and many others The Katrore hill, forming the eastern extremity of the Charwar range, belongs to this formation, and, therefore, differs materially from the greater part of the range, which is composed principally of sandstone, except in the portion opposite Bhooj, where this laminated series also occurs. The strata being principally horizontal, the hills have a conical form.

It is a curious circumstance, that, in the same group, some of the hills of the laminated strata have a thick capping of sandstone, whilst an immediately adjoining peak, of equal height, has none. I conceive the thick beds of the sandstone once covered the whole surface, and that on their upheavement they broke into masses, which have been since denuded from some of the hills, the debris forming the deep sandy plain around Bhooj.

In the hill of Jogé-ki-bit, near Nurra, on the Runn, the beds dip from 40° to 50° to the north, and alternate three times with basalt. The strata vary greatly in character, some of them being very hard and crystalline, particularly those containing calcareous matter; whilst other parts of the series, immediately adjoining, are very friable and earthy. Some of the schists assume the character of a roofing-slate, and others are only soft, laminated blue clay.

A cluster of hills, occupying a surface of three or four square miles to the north-west of the city of Bhooj, called the Bhoodha hills, also belongs to this formation, being composed of slate-clay, tabular sandstone, and limestone slate, in many parts assuming a very friable, earthy texture, and frequently capped with thick beds of coarse, soft sandstone. The strata are often horizontal; in which case the hills are conical; but in many instances the beds incline at a considerable angle; and the hills assume, when capped by the sandstone, the usual form of an abrupt escarpment, with a long inclined opposite side. They are intersected by numerous ravines and nullahs; the looseness of the soil, and peculiar tabular construction of the strata, offering a very slight resistance to the action of the rains. The Chuppal hills, between Guranee and Nurra, in the north-western division of the province, afford another example of the elevation of these strata into hills. They consist of beds of a very earthy and friable description, covered by a thick stratum of hard crystalline sandstone, slightly calcareous; and the lower part forming a sloping talus, capped by the hard rock, in masses 20 feet thick; they appear as if they were surmounted by old ruins or turrets.

Manner in which the Hills have been formed.—From an attentive examination of these hills, I am led to infer, that they have all been uplift-

ed by a movement which proceeded from below; the laminated series having yeilded to the upheaving power, and the loose brittle sandstone having broken off abruptly. That this has been the case with the minor ridges, and what I may term the *natural walls* in the Runn, described in treating upon that district, there can be no doubt, as I have found them at angles, varying from a few degrees above the horizontal position to the vertical, and even turned over beyond that point.

That these beds have been disturbed and broken through by igneous agents is quite evident from the dykes of basalt, which occasionally intersect them.

5. Nummulitic Limestone and Marl.

Although the imbedded fossils of the Nummulitic group resemble those of some tertiary beds of England and France, still the strata of which it consists, differ so totally in mineralogical character and general appearance from any of the other formations in Cutch, that it deserves a separate notice. It is bounded partly by the second or sandstone and coal formation, partly by beds which I have named tertiary, and partly by the alluvial banks of the eastern branch of the Indus, extending from Luckput to a plain between the villages of Wagé-ké-Pudda and Eyeraio, about thirty miles to the southward. It consists of a mass of small Nummulites mixed with Fasciolites; and some of the river banks present a perpendicular section of solid rock, from 60 to 70 feet in height, entirely composed of these small fossils agglutinated together, and varied only by a species of Orbitolites, frequently bent into a saddle shape. This stone has much the appearance of chalk, and the beds are horizontal, except where they have been disturbed. In some parts, however, it is much harder, particularly near the town of Luckput, where it is quarried as a building stone, and is also burnt for lime. The surface-soil is entirely composed of the small fossils lying loose, and generally known by the name of Luckput sixpences.

The beds of nummulitic limestone on which Luckput stands have been affected in a manner deserving of notice.

The high ground to the east of the town sends off three parallel ridges to the westward, ranging nearly east and west. On the two northernmost of these ridges, the north and south walls of the fort of Luckput are built; whilst the southernmost lies at a distance of about 200 yards from the south wall. A kind of valley runs through the town, ending, at its western side, in a swamp, which is crossed by the western wall of the fort. A cut through the northern ridge exposes a very good section of the nummulitic stone, dipping 40° to the north; whilst, in a similar cut

through the southern ridge, made for the purpose of connecting two tanks, the same beds dip from 40° to 50° due south. In the centre ridge the section is not quite so perfect, but the beds are nearly, if not truly, horizontal, forming an anticlinal axis to the other two.

This elevated tract of the nummulitic limestone extends only three miles to the eastward of Luckput, the ground there descending abruptly into a plain, composed of various clays, a coarse ferruginous stone and sandstone, with quantities of selenite scattered about, the whole presenting a confused appearance, as if it had been the site of an igneous outburst. Patches of ground, every here and there, have also an altered appearance, and are covered with small fragments of igneous rock. The plain is bounded to the south by a low range of basaltic hills. From Luckput southward to the village of Punundrow, the same nummulitic rock continues, but varies in hardness from a compact limestone to a white marl. It is also very well exposed between the villages of Eyeraio and Wagè-ké-Pudda, at the southern limits of the formation. To the S. W. of Eyeraio is a plain, composed of a white calcareous marl, and flanked to the south by a low range of hills of the same material, sending off into the plain numerous small projections, with rounded terminations precisely like headlands. Numerous isolated hillocks, or high banks, with sides worn in the same way, and resembling islands, are scattered about the plain, and the whole surface looks as if it had only lately been deserted by water, or as if a violent flood had swept over it. The banks of the small nullahs, which intersect the plain, are composed of gravel, containing rounded masses of a variety of the calcareous marl. Advancing westward, the ground rises a little, and the surface consists of a hard rock, which contains oysters and other bivalves, whilst in some places large patches are entirely composed of silicified corals. I also found in this place fragments of fossil bone, said by Messrs. Clift and Owen to be parts of rib-bones, like those of the *Manatus*, but flatter. To the north, this plain is bounded by a river, the perpendicular banks of which, 60 or 70 feet in height, consist entirely of nummulitic marl, capped by a thin stratum of gravel. In one part, the bed of the river is subjected to the action of a small stream of water, so strongly impregnated with saline ingredients, that large lumps of salt are formed in the hollows worn in the rock, which here assumes the character of a hard limestone, probably in part due to the quality of the water that passes over it. The beds are horizontal, except where they have been disturbed and shattered.

Characteristic Fossils.—The most characteristic fossils of this formation, next to the Nummulites and Fasciolites, are Echini, Galerites,

Clypeasters, and Spatangi. The species of Echini and Galerites are all new. A Clypeaster resembles *C. affinis* of the sandy marl of Brabant; and a Spatangus, the *S. Bucklandii* of the marly chalk of Westphalia; while another species agrees with the *Spatangus acuminatus* of the tertiary deposits of Dusseldorf. The other fossils consist of species of Tellina, Astarte, Cardium, Arca, Pectunculus, Pecten, Nucula, Ostrea, Cerithium, Turbinellus, Globulus, and Seraphe. The Turbinella abounds and is often very large. In the bed of the river above described, I found large blocks composed entirely of small oysters, similar to *Ostrea Flabellulum*, but more regularly and finely striated.

6. Tertiary Strata.

I have called all that portion of the province *tertiary* which is composed of rocks containing fossils belonging to this period. It consists principally of a hard argillaceous grit, interspersed with fossil shells, and covered by beds of pebbles or conglomerate. Some portions of this conglomerate are very coarse, and constituted of rolled or boulder stones loosely connected; whilst other portions are sufficiently indurated to be used as a building stone. A calcareous grit, which soils the fingers like chalk, also occurs in patches, and contains innumerable small shells. It is used for building, and is burnt for lime. The beds are horizontal, and the surface of the country is generally covered with a fine rich soil

At the village of Soomrow, about ten miles north-east of the fort and harbour of Juckow, on the south-western coast, the banks of a broad river-bed are composed partly of a loose gravelly soil, and partly of a very hard, compact, calcareous rock, full of shells, and burnt for lime; and below this rock is a coralline limestone. The river-bed, in some places, is nearly a mile across, the banks being cut into ledges or steps, whilst numerous small hillocks, or high banks of gravel and clay, stand isolated in its middle. Only a small stream now winds from shore to shore. One part of the northern bank rises into a small hill, the surface of which is composed of the same hard, compact, shelly rock as that which is found even with the bed of the river. For some distance north of this spot, the ground is also high, and cut into innumerable ravines; and there are breaks in the surface, as well as circular hollows, or large, deep pits. The natives have a tradition, that an earthquake occurred at this spot, some centuries since, during a severe battle between the Sindians and the natives of Cutch. The raised position of the shelly rock, and the peculiarly rent and broken appearance of the ground, indicate some convulsive movement; and it should be noticed, that, as all the

beds are horizontal, those forming the hill cannot be an unbroken continuation of those in the banks of the river.

This formation continues a few miles further to the northward, where it abuts against the nummulitic beds.

In many places towards its northern limits, it rises into hills, and considerable tracts of high, undulating country; the loftier portions consisting invariably of hard, shelly rock, including large patches, of one or two acres in extent, of silicified corals; and the lower parts, or intervening spaces, of a loose gravel or clay, equally full of organic remains. Some parts of this district, particularly that near the village of Kotra, have a very remarkable appearance, as if they had been subjected to a violent flood, which had washed away the surface-soil to a depth of 30 or 40 feet, leaving a broad, shallow valley, two or three miles across, with numerous isolated and rounded bluff hills of gravel, scattered about its bed. The banks, or bounding lines, consist of low hills, cut into innumerable small ravines; the whole being composed of the same shelly rock, and gravel, and clay as above described.

The fossil shells found in this district occur often in beds, consisting of a single species. One of the hillocks, above described, is about 60 yards long by 20 broad, and 15 feet in height, and is entirely covered with *Ostrea callifera*, lying loosely on a gravelly soil, or cemented into a solid rock. The highest part of the table-land in one place, near the village of Kotra, is also composed solely of oysters, forming a very hard rock or limestone; other isolated banks are completely covered with what appears to be a species of large Serpula, or else fragments of coral. Numerous other fossils are found, either lying loose or imbedded in the rock, and consist of species of Lucina, Venus, Cardium, Pecten, Ostrea, Turritella, and Clypeaster. The Turritellæ are imperfect, but particularly numerous.

This flat valley or broad river-bed (for a small stream still winds through it,) continues to the hills surrounding the town of Mhurr, spreading, in places, into lake-basins, all of the same description as above detailed; but, a short distance south of the Mhurr hills, its course is cut across by a dyke of very compact basalt, of perfectly columnar structure; each face of the polygons being about two feet in breadth. This basalt forms both banks of the river for 50 or 60 yards, and to the height of 20 or 25 feet; the bed of the river being also formed of sections of the columns. The clay through which the basalt passes is hard, and of a brick red; and quantities of iron ore, of a spongiform texture, are scattered about.

The southern base of the Mhurr hills is now approached, and presents a most confused appearance, the country at their foot being shattered in all directions. It is impossible to conceive ground in a more disturbed state. The banks and ridges, varying from 20 to 60 feet in height, are partly composed of a coarse, calcareous grit, full of the marine shells already enumerated, and partly of a blood-red coloured clay, which has apparently been altered by a trap dyke. One bank exposes a section, 60 to 70 feet high, of horizontal layers of gravel, clay, shelly rock, and iron clay, which in one spot appear to have fallen in bodily, dipping abruptly from both sides to a point.

Fossils.—The principal deposit of fossil shells which came under my inspection, was at the village of Soomrow, just described. The specimens which I collected have been examined by Mr. James Sowerby, and found to consist of 33 known genera. Of the 57 species belonging to these genera, 47 are new, 6 are known, and 4 are doubtful. The most numerous among the univalves belong to the genera Mitra and Voluta: there are also great quantities of the genera Cerithium and Terebra; some of the latter being very beautifully marked. The genera Solarium, Conus, and Strombus also abound. Among the bivalves, the Pectens are most numerous; and among the Radiata, are great numbers of Clypeaster. Most of the fossils which I collected, either lay closely on the gravelly bank, or were cemented into large tabular slabs of rock.

I was informed by the natives, that, about the year 1834, great quantities of large fossil shells, called by the country people *Sonk* or *Conk*, being a species of Turbinella, were found in a land-crack, in a field about two miles from this spot; and so perfect, that they were given to the priests of the different temples in the neighbourhood, who, by inserting a metal tube into the apex of the shell, converted them into horns, to call the devout to prayer. I could not, however, find any when I visited the spot, the crack having been filled up by subsequent floods.

Extent of the Tertiary Formation.—These tertiary beds reach, in one place, to the town of Mhurr, a distance of thirty miles from the sea, and extend in a belt of, perhaps, a third of that breadth, throughout the whole southern coast of the province. A narrow line should also be drawn along the borders of the Runn, and around the islands in it, as the fossils, found on the immediate shores, belong to the tertiary period.

7. Alluvial, or Recent Deposits.

These consist entirely of plains covered with soil, evidently detritus which has been washed from the hills, or of land recovered from the sea by the blowing up of sand. The whole of the province south of the volcanic range might be considered alluvial; the surface being composed of a thick soil, formed by the rapid decomposition of the basaltic or igneous hills; but as the banks of the rivers contain tertiary shells, I have thought it better to designate the district as consisting of rocks of that age. The boundary between the tertiary and alluvial districts must, therefore, be considered partly imaginary, as I have thought it more correct to give a general outline, than to mark, with apparent minuteness, limits, which my examination of the district, did not enable me to ascertain.

Land gaining on the Sea.—In many places along the coast, where there are ridges of sand, the land gains upon the sea. These dunes are constantly increasing, from the particles blown up by the sea-breezes, or the south-west winds, which prevail during so great a portion of the year; and the ridges frequently occur in double rows, occupying a considerable breadth, and varying from 50 to 100 feet in height. During strong winds the whole appear to be in motion, from the sand drifting along their surfaces.

At Mandavee, the principal seaport in Cutch, is a ruin on a spot called the Old Bunder, or Quay. It is now about three miles inland, and is situated on the bank of the river, which flows into the sea near the present town; but at the time when this old quay was in use, the town must have been some distance from the present shore. A small temple, built upon a rock, now in the middle of the town, is said to have been at that time also in the sea. Even now, a considerable space, composed of loose sand and sand-hills, intervenes between the town and the sea; and the distance is continually increasing, owing to the quantity of sandy detritus brought down by the river during the periodical floods, and washed back by the sea in the dry season. A bar is also thus formed across the mouth of the river, and the position of it varies so much, and so often, as to render the entrance to the river very difficult. Even boatmen belonging to the port, who have been absent a few months, cannot pilot their vessels in. During very dry seasons, this bar increases to so great a degree as almost to block up the entrance entirely; and the laden boats always strand upon it at high water, their cargoes being carried away by carts, when the tide is out.

At Moondrah, Budraseer, and other seaports up the Gulf of Cutch, the

land also gains upon the sea, rendering necessary the frequent removal further seaward, of the quays or landing-places. Where rivers enter the gulf, this increase of land at their mouths is easily understood, as the sea, for nine months of the year, washes back the sandy detritus accumulated by the river at its delta during the periodical floods. Where rivers flow all the year round, they may be enabled to keep a channel through the deltas constantly free ; but when the stream is inert during three fourths of the year, and the wind and sea are continually at work, the case must be very different.

Marine Forests.—The same operation is in progress at places separated from the main waters of the gulf by small creeks.

Some of these inlets penetrate six or seven miles from the coast through a tract covered for miles in extent with shurbs. At low water, these plants are exposed to their roots ; but at high tides merely their upper branches are visible, so that the boats sail through a marine forest, the sails and yards frequently brushing against the boughs of the trees. The growth of these shrubs is so rapid, that the sailors have very often to force their boats through the upper branches, particularly at the various angles of the very tortuous creeks, when they wish to save a tack, and the wind is scant. The stems and branches of the trees are covered with Crustacea and Mollusca, whilst numerous water-fowl occupy the higher branches ; the whole presenting a most curious picture. That the land should gain on the sea, in these places also, is very natural, as during the monsoons, when the numerous small streams convey their muddy alluvium into the gulf, the roots and stems of the shrubs act as a filter, and the water passing slowly between them, a great portion of the earthy matter is precipitated ; a portion also adhering to the stems.

Effects of Floods.—Considerable damage is frequently done by the periodical floods, which, from the peculiar hilly structure of the country, sometimes rush down with a force, that carries all things before them.

In August 1834, the rains were very violent and long-continued, and did considerable damage. The river, which flows past Nurra, and through the flat, from six to eight miles broad, which extends from the town to the Runn, brought down so much alluvium, as to cover with a fine soil a surface of 150 pragas, or nearly 1000 acres of land. This tract had been sunk by the earthquake of 1819 so nearly to a level with the Runn, as to have remained unfit for cultivation. On the opposite side of the province, at a village called Kundagra, not far from Mandavee, 50 pragas or 300 acres of soil were entirely washed away, leaving a bare

sandy surface, similar to the bed of a river; and not far from the same spot, half a small village, with a quantity of land, was swept bodily into the sea; large trees being uprooted and carried down by the flood. At Pheraudee, 12 miles N. E. from Mandavee, at Mandavee, and many other places, great devastations are said to have been produced. A few similar inundations would alter the features of the country, consisting of such abrupt hills and loose surface-soil.

8. Volcanic and Trappean Rocks.

The district composed of volcanic and trappean rocks is one of the principal features in the geology of Cutch, not only from the space it occupies, but from the phænomena which it presents.

The igneous origin of trap being acknowledged, I shall always speak of it and lava under the comprehensive term of igneous rocks, as in composition they differ only in the proportions of hornblende, felspar, and augite, and as they all appear to have originated in the same cause, and to have equally disturbed or affected the neighbouring strata. But there appears to be a very marked distinction between those rocks which have been in fusion below the surface, and subsequently forced up, and those sedimentary formations, which have an altered appearance, and have been evidently subjected to violent heat since they were deposited in their present position. The latter rocks, however, bear a very small proportion to the former.

Evidence of the disturbing power of Igneous Agents.—It is impossible to desire clearer evidence of the disturbing power of igneous agents than is developed in Cutch. The shattered appearance of the country in some places, the upraised hills in others, with the igneous rock or moving agent, either directly under them, or immediately in front of the outcrop of their strata; the angles to which the beds have been raised varying from a gentle, unfractured slope to the most complete dislocations; the vast variety in the composition of the igneous matter, from the most loose and clay-like form to the most compact and perfect columnar basalt; the crater-like shape and construction of some of the hills, from which large lava or basaltic streams can be traced, prove the igneous origin of these rocks, and the vast effects which they have produced on the general appearance of the country. Moreover, it is not necessary that the igneous matter should be on every occasion apparent; as, where we find a large mass of basalt which has evidently come from below, lying on a plain, behind a hill presenting a bluff cliff towards the igneous rocks,

and the strata sloping sharply from them, the conclusion is obvious, that the hill must have been raised by the outburst of the volcanic matter; and it is equally just to infer, that, in its passage from below, it must have disturbed, more or less, the various beds through which it passed; and, therefore, that the form of many hills may be owing to a latent exercise of this power, even where no traces of the igneous matter are visible near the surface, or near the raised strata. That the greater number of these igneous rocks have been forced up, and are not portions of lava streams which have flowed from volcanos, is very evident, from the manner in which the superimposed strata are affected by them.

In a preceding part of the paper I have described a hill of quartz rock near Mhurr, and shown that its strata have been violently disturbed; and I have also inferred, from the nature of the rock, that its characters are due to grains of sand having been agglutinated by volcanic heat. In detailing the phænomena presented by the second formation, I have shown that its strata have been also subject to great dislocations.

In describing the upper secondary formation, I have stated, that I conceive the hills owe their outline, presenting to the north an abrupt escarpment resting on a slope, and to the south an inclined plane, to the agency of volcanic forces. In the Karee river, near Bhooj, these beds have been disturbed to an extent which defies representation. Near the village of Jarra, on the borders of the Runn, a bank affords a good example of the manner in which this upheaving power has acted. The laminated beds (upper secondary formation) being of a loose earthy character have yielded to the disturbing agent; whilst the overlying compact stone has broken short off, and presents a wall of rock, split by such perfectly vertical lines, that at first sight I thought the stone was columnar.

The range of Roha-ké-Koss, composed of beds of the fourth or upper secondary formation, is a good example of disturbing action. It is situated between the villages of Joorun and Lodye, on the borders of the Runn, and extends nearly east and west for eight miles, presenting, to the north, a perpendicular cliff of sandstone, which rests on a sloping talus of laminated sandstone and slate-clay, and dipping at a high angle to the southward. About three quarters of a mile from this main range, and parallel to it, is a ridge of smaller hills, consisting principally of basalt, intermixed, in some places, with the same sandstone as that of the main hill; and which, in the banks of the nullahs at its base, overlies, the laminated strata. The space between the two ridges is composed of large broken masses of sandstone, covered by a thick bed of gravel

evidently the detritus of the hills. In this instance, the strata of the Koss range dip towards the south ; and, at a short distance to the north of it, we find a mass of basaltic or igneous matter, which probably raised the hills in its passage up, and established itself at their foot. Large basaltic dykes, disturbing the strata through which they pass, are observable in many of the river banks in the immediate neighbourhood.

The beds of nummulitic limestone, on which Luckput stands, present, as before stated (p. 321), most decided marks of elevatory movements, consisting of a central platform of horizontal strata, with inclined beds on the flanks.

Another most striking example of the effects of igneous action in upraising hills, occurs in the nummulitic limestone, near the village of Pun-undrow ; and the phænomena are so strongly marked, that they deserve a detailed description.

On leaving the village of Korah, in the north-west department of the province, and proceeding westward, a range of hills is entered, of small altitude, but covering a considerable area. It is composed of a confused assemblage of basaltic cones in broken columns, or rather of a number of sugar-loaf-shaped masses piled one on the other. The surface of the hills is covered with fragments of a hard greenstone, the crystals of felspar being numerous. The perpendicular banks of the nullahs and ravines which intersect this range, present, in some places, entire sections of the columnar basalt ; whilst others consist of a friable, sandy clay, disposed in horizontal, thinly laminated strata of every shade of black, red, and yellow, to white ; and associated with it is a beautiful purple loam. The basalt sometimes overlies these beds, sometimes forms dykes in them ; and one side of the ravine frequently consists of this variegated loam, and the opposite of basaltic pillars. In many places the ground has an altered appearance ; the ironstone, of which large quantities are lying about, appearing partially fused, and the clays or variegated marls variously acted on, and always accompanied by dykes of basalt. These hills continue about eight miles from Korah to the village of Ukri, where they gradually decline into a plain, throwing off numerous ridges or forks. About three miles distant, a solitary hill, with a flat but uneven top, called Baboa, rises out of the plain. To this hill I wish to draw particular attention ; and the foregoing account of the basaltic range has been given as necessary to a proper understanding of it.

The first part of this plain is composed of thick beds of gravel, but further westward it consists of the nummulitic formation. Out of this soil rises the Baboa hill, composed of hard limestone, full of marine remains. One of the forks projecting from the basaltic range reaches to within

half a mile of the hill, the ground near it being strewed with small fragments of igneous rock.

The cause of the elevation of this hill is, in my opinion, distinctly visible in the banks of a river which passes by its western base. They are from 20 to 30 feet in height, and are composed of white calcareous marl, covered by a thin bed of gravel. Immediately opposite the hill, these beds are cut through by a dyke of very compact dark green basalt, forming, towards the river, a wall about eight feet high ; its base being hid by a talus of gravel. In several places on each side of this dyke, which is about 50 yards in breadth, independent masses of igneous rock break through the marl. They are principally of a blunt, conical form, capped with portions of the marl, and consist of spheroids of basalt, which desquamate in concentric layers, precisely resembling scales of iron. At a short distance up the river, or northward, this marl is covered by a stratified series, dipping at a high angle to the north, and consisting of a yellowish marl, with small imbedded fragments of lignite, covered by a bed of blue clay, containing also fragments of lignite and quantities of an olive-brown earth, in which small pieces of either amber or mineral resin are inclosed. Above this bed is a stratum of red sandstone ; and the whole is covered, at its lower extremity, by a thick bed of gravel. These inclined beds reach the level of the water about 400 yards from the basaltic dyke, beyond which the marl again appears in horizontal beds. Southward of the dyke, the change from the broken part to the undisturbed horizontal strata, is much more abrupt, occurring within a very short distance. On the top of the bank adjoining the south end of the dyke the stratified beds of blue clay, &c. are horizontal.

From the above description it appears, that the only place in which the basalt is exposed, is directly under the hill, no trace of it being discernible either above or below this spot ; also, that the most compact and extensive mass of basalt is exactly under the highest part of the hill ; and that detached masses of igneous rock present themselves, with large portions of the marl adhering to them. A series of stratified beds is also noticed rising from the north towards the hill, meeting the surface at its foot, and is again found in a horizontal position just south of the hill. All these facts surely prove, that the hill must have been elevated by an outburst of igneous matter, which was probably a branch from the basaltic hills to the eastward ; one of its forks reaching within half a mile of the spot.

Quantities, of what I believe to be frothy or foam lava, being a brownish black substance, very vesicular or spongiform, extremely light, and

somewhat similar to a very porous cinder, are found adhering to the marl, and in the rubble of the bank.

Large blocks of the shelly limestone, composing the summit of the hill, are scattered about its sides and base ; and some of them, my guide informed me, fell during the earthquake of 1819 ; and the abrupt and steep sides are, no doubt, due to the action of water. Numerous fossils are found lying about, characteristic of the nummulitic limestone.

I have minutely described this hill, in the hopes of impressing others with the same belief as myself, of the cause of its elevation.

Near the village of Nambye, in the Charwar range, a basaltic dyke traverses beds of thinly laminated slate-clay and layers of limestone slate. In the immediate vicinity of the dyke the strata dip in all directions, and form even anticlinal lines. The basalt is very hard, compact, and of a dark blue colour, and presents irregular masses, without the slightest approach to a columnar structure.

Distinct Periods of Volcanic Eruption.—That the volcanic eruptions have occurred at many distinct periods, is also evident, from the different formations with which the igneous rocks are associated, and from the variations in their characters. Thus, in the same section, the lower part frequently consists of large, rolled, or water-worn masses, whilst the upper portion is columnar : in other places the basalt alternates with a calcareous grit or coarse limestone, having a tabular structure, but always distinctly stratified, and very brittle, so as to present perpendicular banks. This limestone is generally associated with basalt, where the latter is raised into hills ; and from the fact of *angular* pieces of basalt or igneous matter being imbedded in it, would incline one to believe that, in such cases, it must be contemporaneous, though it often regularly alternates with it. In other places the basalt is interstratified with a pure crystalline limestone or travertin.

The principal mass of igneous rocks lies towards the southern department of the province, and forms a group of hills called the Doura range ; the intervening spaces and the ground at their southern base generally assuming a porphyritic structure. The northern parts of the range have, for the greater part, a flat, smooth outline ; but in the interior of the group are many clusters of small, conical hills, arranged round a circular space, inclosing a kind of hollow. The sides of these cones are very steep, and invariably present innumerable horizontal lines, forming rings resembling narrow paths. The surface being covered with basalt, in very small pieces, is totally devoid of vegetation, and has precisely the

appearance of a newly-laid macadamised road. Their interior, however, has a much more solid construction, as is well seen in numerous deep clefts and ravines with which the hills are in all directions intersected.

One of these ravines, near the village of Doonee, is 50 or 60 yards broad, and nearly 100 feet deep; and its perpendicular sides are composed of compact columnar basalt of a greenish grey colour; the columns being perfect polygons, and of a very large size. This rent must have been formed by some convulsion, as it reaches nearly to the summit of the hill; and the only water that could ever have flowed down it being that which falls on its sides and bed, and must be very little.

Alternations of Basalt with Strata of the Upper Secondary Formation.—Near Nurra, on the borders of the Runn, a hill called Jogé-ki-bit, basalt alternates with slate-clay, limestone slate, slaty limestone, and a laminated loam. The strata dip from 40° to 50° to the north, which being at a higher angle than that at which the hill itself rises, it causes them to crop out; the surface being also broken into several distinct ridges. The igneous rock alternates three times. In one instance it underlies a stratum of hard slate-clay; in another it occurs between a coarse, soft sandstone, and slate-clay, and sandstone slate; and it also forms the conical summit of the hill, which is not more than ten feet in diameter. The basalt desquamates in flakes, but has a centre of compact rock. The same inclination of the beds is continued through the hill.

Alternations of the Calcareous Grit with Basalt.—At the village of Doonee, above mentioned, the banks of the river present a perfectly perpendicular wall, from 15 to 20 feet high, and are composed of the calcareous grit, or coarse limestone alternating with basalt, in the following order: first, grit; then a horizontal bed of rounded pieces of basalt; and next, another stratum of the grit, 15 feet in thickness; the whole being covered by the basalt forming the hills.

Another good example of this alternation is near the village of Keroee, at the eastern limit of the formation. The banks of a river are here composed, in some places, of the basalt forming the Doura range; and in others, entirely of the limestone grit, which in one place overlies the basalt, but forced up into anticlinal lines, as if the igneous rock had been protruded from below; the broken state of the strata showing that it was not originally deposited in this position. The bed of the river at this place is entirely composed of basaltic columns; their horizontal sections forming a regular pavement; and large masses of the columns,

occupying from 200 to 300 square yards, and being about eight feet in height, remain every here and there, similar to a field of corn partially reaped. The columns are very regular, generally four-sided, with smooth, even surfaces, and are composed of a hard, compact, dark blue basalt.

Another instance of the junction of the limestone grit with the basalt is near the village of Choolree, a little to the westward of Kaira. The basaltic range is completely divided by a narrow ravine, in which the two rocks appear in contact, the limestone being broken in all directions. One side of the ravine presents a perpendicular cliff, of nearly 80 feet in height, of irregular columnar basalt, overlying a bed of rounded masses of the same, though the opposite bank is composed of the limestone grit. Advancing through the Pass, the basalt terminates abruptly, and is succeeded by the limestone grit, which forms both sides of the ravine. Further on, the basalt again appears in the form of a dyke; beyond which is the grit, once more succeeded by a dyke of basalt, forming, at this extremity of the Pass, both banks. Where the dykes of basalt occur the limestone lies in immense masses, evidently broken off at the time of the projection of the upper bed of igneous rock; being itself of subsequent formation to the lower basaltic bed of rolled masses. This is very distinctly shown at one part of the Pass; and it should be mentioned, that the bed of the ravine consists throughout of irregular or broken basalt.

The intervening spaces and the ground at the base of these hills are composed, for the most part, of a red clay much resembling brick, a variety of it being amygdaloidal, of a darker colour, extremely hard and tough, and containing quantities of calcareous spar, chalcedony, rock crystal, &c.

In some places it forms low ranges of hills of a hard rock, of a dingy red colour, thickly interspersed with cylindrical kernels of zeolite, with a light green coating, some of them dividing into two parts. Other specimens contain numerous crystals of felspar; and, in many instances, all the mineral substances have disappeared, leaving a vesicular mass. Occasionally, thin beds or layers of calcareous spar, of a leek-green colour, are met with, also of rock crystal and chalcedony in all its varieties. The surface of the plains is covered with fragments of these minerals, derived from the disintegration of the amygdaloids, which are rapidly affected by exposure to air and water. Some of the sides of the hills are covered with heaps of rock crystal, as if cart-loads had been purposely thrown down.

Alternation of Basalt with Travertin.—A very good example of successive eruptions of basalt occurs near the small village of Wurrowsow, on the south-western flanks of the Charwar range. This point must at one period have been a lake, it being now a dead flat, about 4½ miles in diameter, and surrounded by low but steep hills, whose surfaces are covered with small fragments of basalt; its general level is about 20 feet above the ground to the east of it. The soil consists of alluvial matter and fine gravel, totally different from the sandy plain by which it is bounded; but its most interesting feature is the basalt at the eastern outlet or break in the low surrounding hills. This mass of trap consists of perfectly polygonal columns about 25 feet in height, but broken into lengths, forming a series of regular steps, cut into a horseshoe shape by a small stream, which discharges itself during the rainy season. The hills that flank it on each side are composed of a base of coarse sandstone capped by an earthy basalt, a dyke of which, 8 or 9 inches wide, has, in one spot, penetrated the subjacent sandstone.

The friable basalt forms the base of the fall. Above the columns the bed of the small stream consists of a loose, calcareous calc-tuff.

This section presents several interesting facts; as, from the alternation of basalt with the limestone or travertin, it is evident, that a considerable time must have elapsed between the igneous eruptions. The variety in the texture of the limestone or travertin may be accounted for by supposing, that the waters under which it was deposited were sometimes perturbed, or rendered muddy by a flood; but at other seasons clear, when a pure calcareous precipitate would take place. The basalt forming the columns is very hard, compact, of a dark blue colour, and smooth surface; and it may be traced to some small hills northward of the spot.

Near this place the surface has been affected in a manner worthy of observation. Every here and there, a small spot, varying in size from 3 to 20 yards in diameter, has been raised into a convex form; the pavement, that covers it, consisting of tabular plates of slaty sandstone, broken into small masses; and the fractured lines generally radiating, though in an irregular manner, from a centre. In some places the tops of these little globular elevations have been removed, leaving a regular circle of stones, whose bounding lines are disposed like the stones of an arch. In other instances they assume a more conical shape, resembling small hillocks, from the upper part of which the outer coating or tabular masses have generally fallen away. When they are of a larger character, the whole presents a heap of broken masses of rock.

Denodur Hill, an extinct Volcano.—Of the detached hills, the elevation of which I conceive to be due to volcanic influence, the principal is that called Denodur, and is situated near the shores of the Runn. It is the largest and highest hill in the country, and is evidently the remains of an extinct volcano, an irregular crater being still visible. In the north side is a large gap, reaching nearly to the foot of the hill, but partially blocked up by a lower ridge, or a kind of traverse. Its western flanks are composed of a series of ridges of laminated clay and loam, interspersed with flat, angular fragments of slaty sandstone and slate-clay. The surface of some of these ridges is smooth, consisting either of thin slabs of slate-clay, or of thicker slabs of a very compact, crystalline, and slightly calcareous stone, the same as that which overlies the laminated series, and forms the walls on the Runn, &c. Near the base of the hill and for more than two-thirds up its side the construction alters, being composed partly of a loose sandstone, and partly of the calcareous grit, containing imbedded, angular fragments of basalt; the uppermost part is a perpendicular wall of basalt, which, apparently, continues all round the top. A stream of very compact basalt runs past its north-western flank, and in other places. Numerous small conical hills, composed of horizontal layers of limestone grit, or of basalt, are scattered over its sides, and its base is covered with a thick mould, formed of decayed vegetables, with earthy matter. Nowhere did I find any traces of recent disturbance, although the people of the neighbourhood, particularly the Jogees, or religious devotees, who inhabit a temple on its northern flank, asserted that fire issued from it during the earthquake of 1819. If it did, there would, of course, be some signs of it remaining; but I was unable to penetrate into the interior of the hill, owing to the dense Bauble Jungle, or crooked thorn tree with which it is covered.

Not far from this place, and adjoining the village of Nuckutrana, is a hill of some size, called Ungia-soorud, the elevation of which has also been effected by volcanic agency. The flanks and base are composed of a very loose, friable, calcareous sandstone and grit, apparently stratified, but inclined at all angles; and the remainder consists of very compact basalt. The hill is divided into two parts by a narrow, tortuous cleft, the sides of which are nearly perpendicular, and composed of irregularly triangular prisms of basalt. The cleft is not more than four feet wide at the bottom, though it is somewhat broader at the top; and as it passes completely through the hill, we must suppose the whole to be similarly composed.

All the other numerous isolated hills scattered over this part of the province, including that called the Nunnaw, next to Denodur, appear to be similarly constructed.

The hill called Lecka, deserves particular notice. It forms one of a group of hills on the borders of the Runn, at the north-western extremity of the province, and is composed of two portions; one consisting of stratified beds of sandstone; and the other wholly of basalt, in irregular, triangular columns. The beds of sandstone are horizontally disposed, and of various colours and textures; the lowest stratum being a coarse, brown, quartzose grit. The igneous rocks crop out in various places near this spot, forming a cluster of small hills between it and the Jooria range; the intervening spaces being broken in the most confused manner.

Recent Outbursts.—Having given as many examples of the elevatory effects of volcanic action as my space will admit, I shall conclude my account of their phænomena with a description of some igneous outbursts of, apparently, a very recent epoch. The principal one occurs at the village of Wagé-ké-Pudda. The spot which has been acted on is a rather high table-land, composed of the nummulitic marl, and is flanked by low, irregular hills of ironstone and gravel, called by the natives Kara Rurraw. The first view of it, is very striking. Conceive a space of about two square miles, blown out into a flat basin, the sides being broken into fissures, with craters, ravines, and hollows; and the interior, or bed of the basin, interspersed with hillocks and cones of every variety of colour, black, red, yellow, and white, and with patches of cinders, similar to the refuse of a furnace; the whole looking as fresh as if the igneous agents were still in operation.

The surface of the table-land immediately surrounding the blown-out space, is covered with a burnt ironstone, divided into irregular cells, similar to Septaria; below which are steep banks, 40 to 50 feet high, consisting of comminuted particles of clay, sand, gravel, scoriæ, and small angular pieces of basalt; the whole being loose, and having a dry and brittle feel.

Within the centre are several small craters, or circular spaces, surrounded by walls of basalt. None of them are perfect circles, being broken through by watercourses; but one has about two thirds of its circumference complete, the sides of which, about forty feet high, are in the upper part quite perpendicular, and consist of very compact basalt, of a columnar structure; while the lower ten feet present a talus, composed of volcanic

sand, and scoriæ in very thin laminæ. Below the columnar basalt is a bed of a friable variety, three feet in thickness. In some parts the columns are capped with a thin band of ironstone. The interior of this crater is about 80 yards in diameter, and consists of volcanic sand, with imbedded angular fragments of basalt. The most perfect of these craters, or circular spaces, are generally hid from view, being approachable only by the narrow ravine forming the outlet of the watercourse which cuts through them. The basalt varies greatly in texture and general appearance : in some places it is columnar, exceedingly hard and compact, in others it contains imbedded crystals of felspar, and it occasionally presents the structure and texture of an amygdaloidal clay. Some varieties also consist of concentric layers of a kind of brittle, clayey substance, inclosing a nucleus of hard rock ; the whole being imbedded in a mass of clay, which looks as if a number of small roots were entwined about it. All the varieties are frequently found in the same bank or hillock.

Several other small basins have been blown out in the surrounding table-land, forming inverted cones, about 15 or 20 feet in depth ; and are composed of the same materials as those just described. Many of them consist entirely of small, brittle particles, of a pale yellow colour, evidently sulphuric. The clay has, in various places, been burnt into a perfect brick ; and the marls, or sandy clays, are frequently of a beautiful bright purple. Quantities of talc, or mica, lie scattered about, twisted and contorted into a variety of shapes ; and some of the iron ore which covers the surface, appears to have been partially fused, consisting of a spongy, vesicular mass. The whole has the appearance of having been for some time subjected to considerable heat, and then suddenly blown up. The cones and banks of loose volcanic scoriæ must be yearly washing away ; and it is difficult to conceive, that the walls of solid basalt forming the sides of the craters, can belong to a similar period, having all the appearance and texture of very old basalt ; but it is possible that a recent eruption may have taken place in the site of one of a more ancient date, thus presenting a mixture of old and recent volcanic products. If it is true, that basalt owes its columnar structure to its cooling slowly under a great pressure, it is impossible that these masses of columnar basalt and the loose cones of scoriæ can be contemporaneous.

In the nummulitic marl forming the banks of a river which flows past this patch of blown-up ground, is a stratum of earth containing small nodules or rounded masses, of a pale yellow colour, translucent and brittle, and which burn with a bright flame, giving out a strong aromatic odour. It is contained in a dry, olive-brown earth, so light as to float in water.

Numerous *Echinodermata*, and other fossils, are found on the table-land, and some of the fields are thickly strewed with casts of a Turbinella of a very large size, the external shell being always wanting. On breaking them, small fragments of igneous matter are found in their interior.

In the table-land just south of the outburst, is a large fissure, about a quarter of a mile in length, 40 yards broad, and 40 or 50 feet deep. One extremity communicates with the river, and the other is rounded, or formed into a basin shape. The sides are perfectly perpendicular; and it is clearly an opening in the ground, there not being the slightest indication of anything of the kind, until directly at its brink. I was informed by a native of the village, (the only present inhabitant,) that smoke issued from the outburst about twenty-two years since; but little dependence can be placed on the statements of these people.

Another similar, but smaller, outburst occurs about three miles south of Mhurr, near the spot in which, in my account of the tertiary deposits, I mentioned that a large basaltic dyke crosses the river. The space here blown out, does not exceed 100 yards in diameter, and 15 feet deep, consisting of similar cones of volcanic scoriæ, and comminuted particles, as above described; but there is no trace of any basalt nearer than the dyke in the river.

From what I have now detailed, it appears, that igneous action has affected all the formations of which the province is composed; and it will also appear, by the following details, that the Grand Runn, the most remarkable feature of the country, owes its peculiar characters to volcanic action.

The Grand Runn.

With a short account of this large and singular tract, I shall conclude the paper. It has been described by Captain Burnes, in a memoir in the library of the Royal Asiatic Society; and referred to, at considerable length, by Mr. Lyell, in his "Principles of Geology."*

This tract, containing an area of upwards of 7000 square miles, exclusive of the space occupied by the Bunnee, and the islands of Puchum, Khureer, &c., is, perhaps, unparalleled in any known part of the globe, as it may be said to be placed on a level between land and water. It is dry during the greater part of the year, when its surface consists of a sandy flat, totally devoid of vegetation; but, perhaps, on account of its

* 5th Edit., vol. ii. p. 183 *et seq.*

saline nature, always sufficiently moist to prevent its particles being drifted. During the prevalence of the south-west winds, however, so much water is blown up its eastern inlet by the Gulf of Cutch, and, at its western extremity, by the eastern branch of the Indus, as to cover its whole surface; augmented by the freshes, which, at the same time, come down the Loonee and Bunass rivers, and the numerous small streams which intersect the northern coast of Cutch. At those seasons, the Runn has all the appearance of a sea, and is passable only on camels, and, in some seasons, with difficulty. It has been described as the dried-up bed of a sea; but it is not easy to account for its drying up, unless we suppose a general depression of the ocean. We must, therefore, look to other causes.

In several parts of the world, particularly in the Baltic, there are undeniable proofs of a gradual rising of the land; and, in time, parts of that sea might be converted into a tract similar to that of the Runn.* It does not become me to inquire whether this gradual elevation is due to a series of so minute elevatory movements as to be unnoticeable, except from the effects which subsequent measurement proves them to have produced, or from a gradual expansion by volcanic heat. But in Cutch we have evidence of movements within a very late date, and every reason to believe that similar ones have occurred at various periods. The earthquake of 1819 is known to have produced a remarkable change on the western extremity of the Runn, by throwing up a mound 50 miles in length, 16 in breadth, and 18 feet high; and by depressing an adjoining tract, so as to convert it, from a cultivated district, into a large salt lagoon. As the changes in level, thus effected, have, however, been detailed in other papers, I shall merely observe, that when I was at Luckput in January, 1834, very little if any change had occurred since Capt. Burnes' visit, in 1828; except that the Sindians had repaired all the bunds across the river, and thus, by preventing further supplies of fresh water, the lagoon had assumed much the same appearance as previous to the freshes of 1828.

I was also informed by a boatman, who constantly plied up and down from Ullah-Bund to the sea, that between Sindoo and Sindree, there is a bank, six miles broad, covered by only one foot of water; and as there is no channel through it, the boatmen are obliged to get out and haul the boats across the bank, after which they follow the windings of the channel to Ullah-Bund. It would therefore appear that this portion

* See Mr. Lyell's Memoir, on the proofs of gradual rising of the land in Sweden. Phil. Trans. 1835, p. 1 *et seq.*

could not have been so much sunk as that around Sindree, and between it and Luckput.

I was also assured that pieces of iron and ship-nails have been thrown up from fissures in the Runn; and Capt. McMurdo* mentions a boat which had been buried under 15 feet of alluvium, having become exposed in a mud-bank, near the village of Wuwania, on the Kattywar side of the Runn, or where it joins the Gulf of Cutch.

The number of places still pointed out as Bunders, or quays, together with the large stones formerly used as anchors, one of which still lies on a small elevation on the Runn, not far from the Puchum Island, and the confident assertion of all the inhabitants on its coast, tend to confirm the opinion that the district must once have been covered by a navigable body of water.

Some parts of the shores have precisely the appearance of having been recently deserted by the sea. This is particularly the case near the village of Charee, which is separated from the Runn by a low range of hills. To the northward of this range is an inlet, about one mile and a half in breadth, and it looks precisely like a small creek or bay from which the tide has just ebbed. Its surface is composed of smooth, whitish clay, with numerous scattered gravel banks, the ends of which have been worn round, and the sides present perpendicular or overhanging banks. Several masses of crystalline sandstone also rise suddenly out of the bed; and some of them consist of immense fragments, which look as if they had been piled one on the other, and have a strange effect from a short distance. Beyond the inlet is another range of hills of the same description, but it is more broken and confused than any other in the country. In some places, the upper stratum of hard rock has been thrown into a position like the roof of a house; in others, it precisely resembles a ruined fort with towers on a hill; but the greater part of the stratum is a confused assemblage of huge fragments of rock. Northward of this range, and separated from it by a narrow belt of the Runn, is a steep conical hill, called Keera, 600 or 700 feet in height, consisting partly of the same materials as the others, and partly of basalt; and it appears to have been formed in a similar manner to the hill called Ungursoorud, before described, and others of that class. It is also more than probable, that the peculiar, fractured appearance of all the ranges is due to the same cause acting at the same period.

Supposing the bed of the Runn to have been raised by a series

* Extract from Captain McMurdo's MS. memoir on Kattywar, in Captain Burnes' Travels in Bokhara, vol. iii. p. 329, *note.*

of violent movements, such as must have upheaved the Keera, and its surface to have been broken, and covered with fragments of rock, its present level outline may be ascribed to subsequent operations. The Runn is bounded to the north, as already stated, by the Thur or Little Desert, a district composed entirely of sand. The Loonee and Bunass rivers also flow through a sandy soil, as do many other streams which enter from the Cutch side. Now, during the periodical floods, vast quantities of sandy alluvium must have been brought down by these rivers, deposited at their mouths, and washed thence and spread over the surface of the Runn by the sea-water annually blown up at its eastern and western extremities. This operation, repeated yearly, would fill up all inequalities, and produce in time a level surface. It is probable, however, that the present state of the district may also be, in some measure, owing to a gradual rising of its bed, as it is only to such operations that some of its shores, as those of the inlet above mentioned, can be ascribed.

There are also many facts to prove, that this tract has been elevated at very different periods. The high hills bordering its southern shore are, as before stated, composed principally of the laminated series, and their surfaces are covered with Ammonites, Nautilites, Belemnites, and other fossils of that geological period ; whereas along its immediate line of shore, there are generally low ridges, composed of rocks full of marine remains of a totally different character, many of them belonging to existing species. Numerous small rocky islets, consisting of shells agglutinated into a solid mass, occur in various parts of the Runn, and are barely raised above its present level. They are probably merely the higher portions of large tracts, the lower parts of which are covered by sediment.

Natural Walls on the Runn how formed.—Still more striking instances of the effects of upheavement, since the Runn assumed its present characters, are exhibited in the detached, elevated masses of rock which I have called the *Natural Walls* on the Runn.

They consist of disconnected portions of rock rising abruptly from the surface of the Runn, and presenting a smooth, vertical wall, occasionally upwards of thirty feet in height, and in one instance upwards of two miles in length. Some of them resemble domed or vaulted buildings, the reversed side consisting of a talus of broken fragments of rock and soil. In one place these walls form a semicircle about 500 yards in diameter, both walls sloping outwards. That the walls have been uplifted into their present form is quite evident, first, from the stones being all on end, that is, with the grain in the direction of their present position,

and peeling off in scales down the face of the wall; and secondly, from my having met with the same phenomena on a smaller scale, in other parts of the country, where the slabs of rock are at all angles, and even, as those before mentioned, turned over. It should be noticed, also, that the borders of the Runn, near these walls, are composed of friable beds of the laminated series, covered with thick tabular masses of hard sandstone, precisely similar to those forming the walls.

Had they been uplifted during the permanent prevalence of the waters, the sloping talus of earth and fragments of rock, with which they are all backed, must have been washed away. It should be stated, that these examples are situated on ground now almost recovered from a state of Runn; some parts having been sufficiently augmented by means of the sandy alluvium, washed down from the neighbouring hills to support vegetation; whereas the isolated rocks, several of which rise out of that part of the Runn, and are still subjected to inundation, have no detritus or talus, but present smooth walls of perpendicular rocks. I could never perceive any water-marks on them, nor any remains of marine testacea, which might occur, had the sea ever washed the present level of their foot. It is probable that their original base lines have become obliterated by the sediment which must have accumulated round them in course of time, and which forms the existing surface.

A very good example of a similar wall occurs in the centre of the province, near the village of Rampoora; it is a ridge of coarse sandstone about 300 yards in length, and from 10 to 15 feet in height, the stones being evidently placed edgeways, and in so regular a manner as to resemble precisely an artificial wall. It rises from a base of the same sandstone, and on one side it is nearly flat, but broken into masses, while on the other side are heaps of stone, broken and confused, and the interstices are filled with sand and small trees. At the extremity of the wall the stones slope up like the end of a roof. In the immediate vicinity of this wall is a small range of basaltic hills, striking however at right angles to the direction of the sandstone ridge.

Some of the rivers which flow towards the Runn from the Cutch side are lost in the sand at their mouths; though at a short distance up the bed of the river, the stream runs freely. It would thus appear, that at these spots, the bed of the Runn has been increased, by the sediment, probably, brought down by the stream; but so loose is the soil, that the water soaks into it and even flows under it, instead of wearing channels. This phenomenon is observable in the sandy beds of many of the rivers in the province. The stream may be noticed running with some rapidity and of a sudden to cease, the bottom of the river presenting a smooth sandy surface; but a mile lower down the water again issues and con-

tinues its course; the intervening parts being sometimes quite hard and dry; in others forming very dangerous quicksands.

The natives have various traditions that the drying up of this sea was sudden, and that boats were tossed on the land and wrecked; they pretend also to assign a date to this event, but their accounts differ so materially and are so vague, that not the slightest reliance can be placed upon them, except to the general fact.

It is evident that the Runn could not have been drained by the bursting of its boundaries, at least since it was deep enough to be navigable; because its present surface, notwithstanding the sediment which yearly accumulates on it, is even now so little raised above the sea's level as to be flooded by the mere effects of the wind; but the most probable supposition is, not that it was ever a detached inland sea or lake, but that it communicated with the ocean by its present outlets, and that its bed has been raised, partly perhaps by a gradual movement, and partly by violent upheavements during earthquakes. Even such marked changes of level as the raising of Ullah-Bund, and the sinking of the ground near the large town of Luckput, would have passed unrecorded but for the accidental circumstance of the district having been visited by a British officer. Other portions of this vast area, the greater part of which is never traversed by man, may have been similarly affected at that time, and yet the changes remain unkown.

Successive Marine and Freshwater Beds.—The submerged tract near Luckput, or Lake of Sindree, may, I think, illustrate the manner in which successive marine and freshwater deposits may be produced. This tract was at one period a richly cultivated district, periodically flooded by a branch of a great river, and produced large quantities of rice. In this state numerous land testacea no doubt occupied it, and were mixed with the remains of fluviatile species brought down by the floods. The bones of animals used in agriculture, and those of various domestic species, also the remains of broken pottery, perhaps coins, and other proofs of civilized life, might likewise have been imbedded. Suddenly, owing to the damming up of the river by the Sindians, the supply of fresh water ceased, and the tract was no longer cultivated or inhabited. Some time after this an earthquake occurred, uplifting one part and depressing below the level of the ocean another, which was immediately converted into a salt lake. A perfectly new description of deposit and organic remains must then have been accumulated, consisting wholly of marine animals, principally such as inhabit shallows and tideways. Again, owing to the sudden melting of the snow on far distant mountains (the Himalayahs) the waters of the river came down with such force as to burst all the bunds built across it, as well as that

thrown up by the earthquake, and covered the tract with fresh water, or perhaps with fresh at its upper or northern extremity, and brackish at its southern near the sea. Supposing this state of things to have remained for some time, the river continuing to pour its water into this lagoon, another change would take place in the description of the sedimentary deposit. Once more the bunds were erected across the river, the supply of fresh water ceased, and as that on the lagoon evaporated, the sea again flowed in and converted it into a salt lake, which is its present state. All the above changes are known to have occurred; and it is easy to suppose that if the shallow part at Sindoo were slightly raised above its present level, thus shutting out the sea, the part around the Fort of Sindree would be converted once more into dry land. If, therefore, at any future period, the river should again cut a channel, the banks might present various, regular beds alternately enclosing marine and freshwater exuviæ, the latter being also associated with land productions.

The ruins of one of the towers of the Fort of Sindree remained, when I visited Luckput in 1834, and in all probability now stand as a monument of the changes, which are daily taking place on the earth's surface.

Conclusion.—In concluding this paper, I have only to observe, that I have throughout endeavoured to describe facts as they appeared to me at the time I examined them, without regard to any particular theory; and if I have failed in making my descriptions intelligible, I have only to plead the difficulty of having had a great deal to describe in a limited space. As the country to which this memoir relates is, however, unfortunately from its geographical position, beyond the reach of general observers, I am induced to hope, that this sketch, however imperfect, may be found to possess some interest.

For the arranged list of fossil shells, given in the Appendix, as well as for all my information on that subject, I am entirely indebted to Mr. James De Carl Sowerby, who had my specimens (now in the cabinets of the Geological Society) for some time in his possession for examination.

Note.—In conformity with our practice of extracting from scarce or expensive works such articles on matters of Science connected with this country, as appear in European Periodicals, we have taken from the Transactions of the Geological Society of London the foregoing articles. We wish we could give copies of all the figures of fossils which accompany the original text, forming a most valuable addition to the palæontology of India, but their number precludes us from so doing—the difficulties and expence attending the execution of so great a number of lithographs being greater than the resources of this Journal could meet.—Ed. Madras Journal.

APPENDIX.

SYSTEMATIC LIST OF ORGANIC REMAINS, THE PLANTS DETERMINED BY MR. JOHN MORRIS, AND THE REMAINDER BY MR. JAMES DE CARL SOWERBY, A. L. S.

The fossils considered as belonging to previously described species, are distinguished by a reference to the work in which they were first noticed; the new species are described in the explanations at the end.

Class, Genus, and Species.	Formation.	Locality.	Remarks by Capt. Grant.
Plantæ.			
Ptilophyllum acutifolium	Sandstone, Clay with Coal.	South of the Charwar range.	
——— *Cutchense*			
Lycopodites affinis			
Fucoides (*Codites?*) *dichotomus.*			
Stems of Equisetites or a Monocotyledonous Plant			
Polyparia.			
Lycophris Ephippium (p. 321 *Orbitolites*)	Nummulitic group.	Baboa Hill and Wagé-ké-pudda.	Very abundant.
——— *dispansus*	Ibid		
Radiaria.			
Crinoidal stems	Upper Secondary.	Charee	Found on hills near Charee with Ammonites and other fossils.
Echinus dubius	Nummulitic group.	Baboa Hill, Wagé-ké-pudda.	
Galerites pulvinatus	Ibid	Baboa Hill	
Clypeaster affinis? Goldfuss, XLII. 6.	Ibid	Ibid. and near Joongrea.	
——— *varians*	Ibid	Ibid. and Wagé-ké-pudda.	

—— *depressus*	Tertiary	Soomrow	Found in great numbers, and similar in colour and form, to recent specimens, but flatter.
—— *oblongus* Lamk.	Ibid	Between Joongrea and Kotra.	
Spatangus obliquatus	Nummulitic group.	Baboa Hill	Very numerous.
S. Buckl.? Goldf., XLVII. 6.			
—— *acuminatus?* Goldf., XLIV. 2.	Ibid	Ibid.	
—— *elongatus*	Ibid	Ibid.	
ANNULATA.			
Serpula? recta	Tertiary	Near Kotra.	Bodies of similar form occur in vast quantities on isolated banks in the river near Kotra.
Siliquaria Grantii	Tertiary	Borders of the Runn.	
CIRRIPEDA.			
Balanus sublævis	Ibid.	Soomrow.	
CONCHIFERA.			
Pholadomya? inornata	Upper Secondary	near Charee	Found on some hills bordering the Runn, which have been much disturbed by volcanic action.
—— *granosa*	Ibid	Ibid	
—— *angulata*	Ibid	Ibid	
Amphidesma? ovale	Ibid.	Ibid.	
—— ? *hians*	Ibid	Ibid.	
Corbula lyrata	Ibid	Ibid.	
—— *trigonalis*	Tertiary	Borders of the Runn.	
—— *rugosa*	Ibid	Ibid.	
Tellina exarata	Ibid	Soomrow.	
Astarte unilateralis	Upper Secondary	Charee.	
—— *pisiformis*	Ibid	Ibid.	
Venus granosa	Tertiary	Soomrow.	
—— *cancellata*	Ibid	Ibid., Kotra.	
—— *nonscripta*	Ibid	Soomrow.	
Pullastra? virgata	Ibid	Ibid.	
Cardita intermedia? Brocchi, XII. 15.	Ibid	Ibid.	

Class, Genus, and Species.	Formation.	Locality.	Remarks.
Trigonia costata, var. M. C., LXXXV.	Upper Secondary	Charee	Found in the same hills with the Pholadomyæ.
—— *pullus*	Upper Secondary	Charee	Found in the same bed as *Trigonia costata.*
Cardium intermedium	Nummulitic group.	Baboa Hill.	
—— *ambiguum*	Ibid.	Ibid.	
—— *triforme*	Tertiary	Soomrow.	
Cucullæa virgata	Upper Secondary	Hubbye Hills	A pass in the hills between Hubbye and Joorun is paved with these shells imbedded in a hard rock.
Arca hybrida	Nummulitic group.	Baboa Hill.	
—— *radiata*	Tertiary	Soomrow.	
—— *tortuosa ?* Linn.	Ibid.	Ibid.	
Pectunculus pecten	Nummulitic group.	Baboa Hill.	
Nucula tenuistrata	Upper Secondary	Hubbye Hills	In the same masses with *Cuc. virg.*
—— *? cuneiformis*	Ibid.	Charee	These shells form stony banks which project slightly above the bed of the Runn; also solid rocks in the Hubbye Pass.
—— *Baboensis*	Nummulitic group.	Baboa Hill.	
Pecten partitus	Upper Secondary	Hubbye Hills.	
—— *lævicostatus*	Nummulitic group.		
—— *Soomrowensis*	Tertiary	Soomrow.	
—— *articulatus*	Ibid.	Banks of the Runn.	
Plicatula pectinoides	Upper Secondary	near Charee.	
—— M. C., CCCCIX.	Ibid.	Katrore Hill.	
Exogyra conica M. C., XXVI., DCV.	Ibid.	Ibid.	
Gryphæa globosa ? M. C., CCCXCII.	Tertiary	Kotra.	
Ostrea Marshii M. C., XLVIII	Upper Secondary	Katrore Hill, Charwar range.	Found in a bank in the hill.
—— *carinata ?*	Nummulitic group.	Charee.	

M. C., CCCLXV.			
—— *callifera ?* Lamk.	Ibid.	Wagé-ké-pudda.	Isolated banks in the broad river-bed near Kotra are completely covered with these oysters.
—— *orbicularis.*	Ibid.	Luckput.	Masses, 15 to 20 feet thick, composed of this shell are scattered in the bed of the river.
—— *angulata*	Tertiary	Kotra.	
—— *Flabellulum* M. C., CCLIII.	Ibid.	Cheeosir.	The banks of a river near Cheeosir are composed of a grit full of these fossils, and of a Cardium. They are generally distributed through the tertiary district.
—— *tubifera*	Ibid.		
—— *lingua*	Ibid.	near Joonagrea and Kotra.	
Terebratula intermedia, var. M. C., XV. 8.	Upper Secondary.	Charee.	
—— —— *biplicata, var.* M. C., XC. & CCCCXXXVII.	Ibid.	Jooria Hill.	
—— —— *sella, var.* M. C., CCCCXXXVII. 1.	Ibid.	Pass of the Hubbye Hills.	
—— —— *concinna ?* M. C., LXXXIII. 6.	Ibid.	Jooria Hill.	
—— *nobilis*	Ibid.	near Charee.	Very numerous.
—— *dimidiata ?* M. C., CCLXXVII. 5	Ibid.	Ibid, Jooria Hill.	One specimen was found in gold-coloured oolite, in the highest part of the Jooria Hill on the borders of the Runn.
—— *major*	Ibid.	Charee.	
MOLLUSCA.			
Bulla lignaria, Linn.	Tertiary.	Soomrow.	From the lower part of the hills. The shells found in this position differ from those in the highest part of the same hills, and appear to have been deposited in the shores of the Runn since those hills were raised.
Neretina grandis	Nummulitic group.	Wagé-ké-pudda.	
Natica obscura	Tertiary.	Soomrow.	
—— *callosa*	Ibid.	Ibid.	
Globulus obtusus	Nummulitic group.	Baboa Hill.	
—— *? anguliferus*	Tertiary	Borders of the Runn.	

Class, Genus, and Species.	Formation.	Locality.	Remarks.
Solarium affine	Ibid.	Soomrow.	Very numerous.
Trochus cognatus	Ibid.	Ibid.	
Turritella angulata	Ibid.	Ibid.	Very numerous.
——— *assimilis*	Ibid.	Ibid.	
Terebra reticulata	Ibid.	Ibid.	
Cerithium rude	Ibid.	Ibid.	Numerous, but imperfect.
——— *corrugatum*	Ibid.	Ibid.	
Fusus ? granosus	Tertiary.	Soomrow.	
——*læviusculus*	Ibid.	Ibid.	
——*nodulosus*	Ibid.	Ibid.	
——, or *Murex hexagonus*	Ibid.	Ibid.	
Ranella bufo	Ibid.	Ibid.	
Rostellaria rimosa M. C., XCI., not Lamk.	Ibid.	Ibid.	
———*rectirostris*, Lamk.	Ibid.	Ibid.	
Strombus deperditus	Ibid.	Ibid.	
———*nodosus*	Ibid.	Ibid.	
Cassis sculpta	Ibid.	Ibid.	
Buccinum pumilum	Upper Secondary ?	Mhurr.	Found in a mass of white marl.
Turbinellus bulbiformis	Nummulitic group.	Wagé-ké-pudda.	Found in vast quantities, and sometimes very large.
——— *affinis ?*	Tertiary.	Soomrow.	
Mitra scrobiculata ? Brocchi	Ibid.	Ibid.	
——*fusiformis*	Ibid.	Ibid.	
Voluta jugosa	Ibid.	Ibid.	Among the most numerous fossils found at Soomrow.
———*dentata*	Ibid	Ibid,	
Cypræa depressa	Nummulitic group.	Baboa Hill.	
———*humerosa*	Tertiary.	Soomrow.	

——— *prunum*	Ibid.	Eyerau.	
——— *digona*	Ibid.	Soomrow.	
——— *nasuta*	Ibid.	Ibid.	
Seraphs	Nummulitic group.	Baboa Hill.	An imperfect cast.
Terebellum obtusum.	Tertiary	Soomrow.	
Oliva pupa	Ibid.	Ibid.	Found in great quantities.
Conus brevis	Ibid.	Ibid.	Very numerous.
——— *militaris*	Ibid.	Ibid	
——— *catenulatus*	Ibid.	Ibid.	
——— *marginatus*	Ibid.	Ibid.	
Belemnites canaliculatus ? Schlotheim	Upper Secondary.	Charee.	
——— ——— ———	Ibid.	Ibid.	
Nautilus hexagonus ? M. C., DXXIX.	Ibid.	Ibid.	
Ammonites Herveyii, var. M.C., CXCV.	Ibid.	Ibid.	Ammonites are exceedingly numerous throughout the Upper Secondary district, and are generally loose on the surface. In the text (p. 318) eight species are mentioned as new, but on further examination two of them have been ascertained to be only varieties.
——— *elephantinus*	Ibid.	Ibid.	
——— *formosus*	Ibid.	Ibid.	
——— *lamellosus.*	Ibid.	Ibid.	
——— *Opis*	Ibid.	Ibid.	
——— *arthriticus.*	Ibid.	Ibid.	
——— *ignobilis*	Ibid.	Ibid.	
——— *corrugatus ?* M.C., CCCCLI.	Ibid.	Ibid.	
——— *armiger*	Ibid.	Ibid.	
Nummularia acuta.	Nummulitic group	Luckput.	Nummularia are so abundant as almost to compose a large tract on the north-west frontier of the province.
——— *obtusa.*	Ibid.	Wagé-ké-pudda.	
Fasciolites, (Parkinson) elliptica	Ibid.	Ibid. Baboa Hill.	

Plants from the Sandstone and Clay, with beds of coal: pp. 312, 317.

*Described by Mr. J. Morris.**

Ptilophyllum.

Stem—? Fronds pinnate; pinnæ closely approximated, linear, lanceolate, more or less elongate, imbricate at the base, attached obliquely; base semicircular or rounded; veins equal, slender, parallel.

We have ventured to form these fossils into a distinct genus, conceiving that the circumstances of the oblique insertion of the pinnæ and their overlapping each other at the base, are characters too important to admit of their being united to the genus *Zamites*, to which somewhat similar fossils have hitherto been referred; the *Z. pectinata* of the Fossil Flora belongs to this genus, and a careful revision of the fossil *Cycadeæ* may probably discover other species having this mode of attachment; from the structure of the frond they may, however, be considered to belong to *Cycadeæ*, and to differ from *Zamites* in the oblique insertion of the pinnæ at the base, and from *Coniferæ* by the absence of a primary vein in the pinnæ.

Ptilophyllum acutifolium.

Frond pinnate; pinnæ narrow, linear-elongate, acute at the apex.

This species differs from the *Z. pectinata* of the Fossil Flora, in its pinnæ being narrower, longer, and more acute; and more nearly resembles the *Polypodites pecteniformis* of Sternberg.

P. Cutchense.

Frond pinnate; pinnæ short, scarcely overlapping at the base, apex obtuse.

This specimen has been also referred to the genus from its pinnæ (although wider apart than in the other species) having apparently a rounded base; but the absence of all trace of venation in this fossil must render its correct determination very doubtful. It resembles in form the *Z. Bucklandii* of Sternberg, parts 5 and 6, t. 23, f. 2, or even *Z. taxina* of the Fossil Flora; and it might also be compared to some pinnatifid Polypodiums, as *P. plumula* and *P. taxifolium.*

It is much to be regretted, that more numerous and better-preserved portions of these specimens have not been obtained, so as to compare them more rigidly with the already known forms of fossil vegetation; for it is remarkable the analogy that some of them present to the Stonesfield slate plants.

Lycopodites affinis.

* The plants are stated in p. 314 to consist of ferns and reeds, but when the Memoir was passed through the press the specimens had not been examined by Mr. Morris.

Stem ——— ? branches linear-elongate, leaves distichous, alternate, ovate-lanceolate, acuminate, adnate at the base.

This specimen has been referred to Lycopodites from its resemblance to the barren portions of *Lycopodium Jussieni* and *L. volubile.*

——— ———,

These specimens were probably portions of stems belonging either to *Equisetites* or some monocotyledonous plant.

Fucoides dichotomus.

Frond compressed ? dichotomous ; branches unequal, patulate, apex obtusely rounded.

Shells from the Upper Secondary Formation described by Mr. James de Carl Sowerby.

Pholadomya ? inornata. Transversely elongate, ovate, gibbose, concentrically corrugated ; beaks very near the anterior extremity ; longitudinal ribs very obscure, rounded. Width 1½ inch, length nearly 11 lines.

Loc. near Charee.

Pholadomya granosa. Ovate, subtriangular, gibbose, ornamented with four or five rows of transversely-elongated and but slightly-elevated tubercles ; the anterior side nearly straight-flattened, the posterior produced ; beaks very prominent. Length 2 inches, width the same.

Loc. near Charee.

Pholadomya angulata. Subtrigonal, gibbose, ornamented with four or five sharp ribs, which are most prominent near the edge ; anterior side straight, nearly flat. Length and width equal ; in some specimens 2 inches.

Ph. angulata approaches *Ph. Murchisoni* var. of Phillips. (Geol. of Yorks., Pl. VII. f. 9.)

Loc. near Charee.

Amphidesma ? ovale. Transversely elongate, ovate, convex, slightly wrinkled, anterior side small, truncated, distinguished from the rest of the shell by a gentle depression ; posterior extremity rounded, rather pointed. Length 11 lines, width 1 inch 4 lines.

Loc. near Charee.

There is no proof whatever that either this or the following belong to the genus *Amphidesma* ; they are, however, very nearly related to *A. donaciforme* and *A. securiforme* of Phillips.

Amphidesma ? hians. Transversely elongated, convex, slightly wrinkl-

ed ; sides gaping ; the anterior small, separated from the rest of the shell by an obscure depression ; the posterior rounded, a little flattened. Length 1 inch, width more than $1\frac{3}{4}$ inch : the specimen being broken we have not the measure complete.

Loc. near Charee.

Corbula lyrata. Rounded, triangular, convex, transversely ribbed ; ribs about 15, prominent, rounded ; posterior side of the larger valve formed into a distinct lobe, convex, nearly smooth—the beak of the same valve much incurved, the margin toothed. Length and breadth nearly equal, sometimes exceeding half an inch.

Occurs grouped in dense masses with *Trigonia Pullus*, a smooth *Uncula*, &c.

Loc. near Charee.

Astarte unilateralis. Transversely obovate, anteriorly truncated, convex, rather flattened and marked with 8 or 9 concentric rugæ near the beaks. Anterior side at right angles with the hinge line ; lunette concave, ovate, pointed. Width greater than the length, but variable in proportion, generally about $1\frac{1}{2}$ inch.

Loc. near Charee.

Astarte pisiformis. Nearly globose, with pointed beaks ; marked with 8 or 9 sharp transverse ridges ; edge toothed. Length 3 lines.

Loc. near Charee.

Trigonia costata, var. This shell varies slightly both in form and markings—generally the form is between that of *T. costata*, Parkinson or M. C. t. 85 ; and *T. elongata*, of M. C. t. 431 ; which Lamarck, apparently with justice, considers to be but one species.

Loc. near Charee.

Trigonia Pullus (M. C. t. 508, f. 2, 3.) ? The markings on the posterior side are not so regular as in the English specimens, but there is no other difference.

Loc. near Charee.

(Fossils from the Upper Secondary Formation, Cutch.)

Cucullœa virgata. Transversely elongato-quadrate, with projecting incurved beaks, very convex, marked with many longitudinal irregular, sharp ribs ; posterior margin obliquely truncated. Length $1\frac{1}{2}$ inch, width $2\frac{1}{4}$ inches.

Loc. Between Hubbye and Joorun.

Nucula tenuistrata. Obliquely oval, finely striated concentrically; beaks close to the anterior extremity. Length 4 lines, width 5 lines.

Specimens very imperfect, along with *Cucullæa virgata*

Loc. Between Hubbye and Joorun.

Nucula? cuneiformis. Transversely elongate-elliptical, gibbose, smooth; beaks close to the anterior extremity, small, incurved. Length 6 lines, width 10 lines.

Loc. near Charee.

Pecten partitus. Broad, short-elliptical, depressed, marked with two concave radii, which divide the surface into three parts, both externally and internally, the lateral parts being flattened; concentrically and minutely waved, waves alternately larger and smaller; ears small, nearly equal. Length 6 lines, width 5 lines.

Loc. Hubbye Hills.

Plicatula pectinoides, (M. C. t. 409.). If this differ at all from the British species, it is in having rather more the habit of an *Ostrea*, which is apparent in the expansion of the edge.

Loc. near Charee.

Exogyra conica, (M. C. t. 26 and 605.). The few specimens most detached from the matrix appear not to be quite so deep as those figured in the Mineral Conchology.

Loc. Katrore Hills.

Ostrea carinata (Lam. Hist. Nat. VI. 216. M. C. 365.)? The specimens being generally much concealed in the stone or broken, the determination of the species is not possible; the most perfect individuals resemble the young state of *O. carinata*, but that species is so near in some slates to *O. gregaria*, (M. C. t. 111.) and *O. solitaria* (M. C. t. 468.), that fragments cannot be distinguished.

Loc. near Charee.

Ostrea Marshii, (M. C. t. 48.). The *O. Marshii* varies so much in different localities, that we find no difficulty in referring this shell to that species, although the plaits are more numerous than usual.

This specimen is accompanied with an imperfect *Plicatula*.

Loc. Katrore Hill.

Terebratula intermedia, (M. C. t. 15. f. 8.) *var*. A small specimen, and rather more deeply plaited than most of the European varieties of the species.

Loc. near Charee.

Terebratula biplicata, (M. C. t. 90 and 437, f 2, 3.) *var*. A variety of this variable species found in the red chalk at Hunstanton, is precisely simi-

lar in form to our specimen, except that it wants the angle on each side of the beak which is here obscurely visible.

Loc. Jooria Hill.

Terebratula Sella, (M. C. t. 437, f. 1.) *var.* A rather longer shell than the British fossil, and deficient in the central plait which most generally occurs in full-grown individuals of that species.

Loc. Pass of the Hubbye Hills.

Terebratula concinna, (M. C. t. 83, f. 6.) ? A larger shell than the one figured in M C. and not so neat, but hardly possessing any character sufficiently strong to mark it as a species ; there are, however, rather fewer plaits.

Loc. Jooria Hill.

Terebratula nobilis. Tetrahedral, rounded, sharply plaited ; plaits about 16, extending to the beaks, 4 or 6 of them much elevated along the middle of the disk ; beaks small, adpressed ; sides concave near the beaks.

A large handsome species ; when young the general form is depressed, but the middle is even then much elevated. Length and width, each $1\frac{3}{4}$ inch, depth of the valves united, sometimes more than 2 inches.

Loc. near Charee.

Terebratula dimidiata, (M. C. t. 277. f. 5.)? Whether this be *T. dimidiata* or *T. inconstans*, (M. C. t. 277, f. 4.) is a question the specimens are not perfect enough to settle. The flattened form of the specimen figured agrees with that of *T. dimidiata*, but the beaks of our specimens appear too much incurved (perhaps from pressure) and so to approach *T. inconstans*.

Loc. Jooria Hill, and near Charee.

Terebratula major. Transversely obovate, gibbose, plaited ; plaits angular, extending to the beaks, about 30, half of them on one side of the front slightly raised ; beak of the larger valve prominent, slightly incurved. A larger species than the last, of the same family, well distinguished by its width and even surface. Length, $1\frac{3}{4}$ inch, width $2\frac{1}{4}$ inches, depth of the valves united $1\frac{1}{2}$ inch.

Loc. near Charee.

(Fossils from the Upper Secondary Formation, Cutch.)

Buccinum pumilum. Ovate, pointed, transversely striated ; spire small ; whorls 4, smooth in the middle, slightly convex ; aperture ovate, pointed at both extremities. Height 3 lines, diameter 2 lines.

Loc. Mhurr.

Belemnites canaliculatus, Schloth. (Zieten, t. xxi. f. 3.) ? The fragments we have of this Belemnite agree well with Zieten's figure of *B. canaliculatus*, which is very probably not distinct from *B. sulcatus* of Miller (Geol. Trans., 2nd Series, vol. ii. part 2, p. 59, Pl. VIII f. 3).

Loc. near Charee.

Belemnites ——— ? A nearly cylindrical fragment without a sulcus. Very like *B. elongatus* of Miller.

Loc. near Charee.

Nautilus hexagonus (M. C. t. 529) ? Flatted spheroidal, with a very small umbilicus; front approaching to flat; sides rather conical; septa 15 in a whorl; aperture wider than long; siphuncle unknown. Diameter 3¼ inches, thickness 2¼ inches, length of the aperture 1½ inch.

This differs from *N. hexagonus* in having a smaller umbilicus and in being more rounded. It wants the line that occurs in the middle of the front of *N. lineatus*, which it nearly resembles.

Loc. near Charee

Ammonites Herveyi, (M. C. t. 195, Zieten, 19. t. xiv. p. 3.) *var.*

This differs from the English specimens only in having a wider umbilicus. It agrees well with Zieten's figure, which differs a little from the English specimens, to which *A. macrocephalus*, figured by the same author at Tab. 5. f. 1 and 4., approaches nearer.

Loc. near Charee.

Ammonites elephantinus. Approaching to globose, with a very wide umbilicus exposing the inner whorls; whorls obtusely angular at their sides, crossed by very prominent rounded costæ, which divide into two as they pass over the front; aperture transversely elongated, gently arched. Diameter 4 inches, thickness 2½ inches, length of aperture above an inch.

Loc. near Charee.

Ammonites formosus. Discoid, with a rounded edge, umbilicate, radiated; umbilicus narrow, acutely conical; radii numerous, slightly elevated, obscure near the umbilicus, often forked near their commencement, passi g in a direct course over the front; aperture sagittate, with truncated angles. Diameter 5 inches, thickness 2¼ inches, length of aperture 1½ inch.

Loc. near Charee.

Ammonites lamellosus. Discoid, thick, with a rounded margin, umbilicate, radiated; umbilicus narrow, exposing a small portion of each inner whorl, smooth; radii numerous, elevated into obtuse lamellæ, commencing with a curve upon the edge of the umbilicus, often forked upon the

middle of the sides, bent forward as they pass over the margin. Diameter 4 inches, thicknes $1\frac{3}{4}$ inch.

Loc. near Charee

Ammonites Opis...Discoid, compressed, with an obtuse edge, radiated; inner whorls one-third exposed; whorls slightly convex on their sides, their inner edge rounded; radii commencing with a curve at the inner edge of the whorls, numerous, prominent, rounded, often forked near the middle, slightly bent forward as they pass over the front; aperture elliptical. Diameter $4\frac{1}{4}$ inches, thickness $1\frac{1}{4}$ inch, length of aperture $1\frac{1}{4}$ inch.

Loc. near Charee.

Ammonites arthriticus. Discoid, thick, with convex whorls and a rounded margin, tuberculated and ribbed; whorls half-exposed, about 4, their inner margin smooth; tubercles large, near the middle of the sides of the whorls, about 12 in each whorl; ribs prominent, rounded, 3 or 4 from each tubercle and sometimes an intermediate one; aperture nearly circular, completed 3 or 4 times in each whorl with a thickened edge. Diameter $2\frac{1}{2}$ inches, thickness 1 inch.

Loc. near Charee.

Ammonites ignobilis. Discoid, depressed, umbilicated, keeled, radiated; front rounded with a slightly prominent entire keel; umbilicus small, with squarish edges, exposing a small portion of the inner whorls; radii covering half the whorl, in pairs or forked, commencing and terminating with obscure tubercles, waved; aperture sagittate, narrow. Diameter nearly 3 inches, thickness 10 lines. Length of the aperture $1\frac{1}{4}$ inch.

Loc. near Charee.

Ammonites corrugatus (M. C. t. 451, f. 3.)? An imperfect specimen rather more strongly ribbed than the one figured in Mineral Conchology.

Loc. near Charee.

Ammonites Armiger. Discoid, inner volutions exposed; inner whorls radiated and furnished with a row of tubercles on their sides; outer whorl with a row of tubercles near the inner edge, and a row of spines near the outer edge on each side,—the tubercles and spines connected by thick ribs; margin flat; aperture oblong, squarish. Diameter 7 inches.

Strongly resembling *A. perarmatus* (M. C. t. 352.), but the whorls increase more rapidly in size, and the aperture is longer. Probably *A. Catena*, *A. perarmatus*, and this are only varieties of one species.

Loc. near Charee.

Crinoidal stems, apparently of 3 species.

Loc. near Charee.

(Fossils from the Nummulitic Limestone and Marl, Cutch, p. 321.)

Cardium intermedium. This shell, of which we have only casts, is very near in form to *Cardita intermedia* of Lamarck; the hinge, as we learn from the impression, however, wants the long marginal tooth, which marks the genus *Cardita.* Length 1 inch, width the same.

Loc. Baboa Hill.

Cardium ambiguum. The furrows upon the surface of this cast are deeper than they would be in a cast from the European *C. serratum;* which, in the general form of the shell and number of furrows it resembles more strongly than it does the *C. lævigatum* of the Indian Seas. Length 2 inches 1 line, width 1 inch 10 lines.

Loc. Baboa Hill.

Arca hybrida. Transversely oblong, oblique, longitudinally costated; costæ strongly marked with the lines of growth,—those on the anterior side, furrowed along the middle; area narrow. Length 11 lines, width 14 lines.

Nearly related to the recent *A. rhombea*, but with a narrower area between the beaks, approaching to *A. Indica* of Linnæus.

Loc. Baboa Hill.

Pectunculus Pecten. Orbicular, convex, ribbed; ribs about 30, radiating, crenated by the lines of growth; hinge-line short. Length 10 lines, width 11 lines.

Very nearly like *P. pectinatus* of Lamarck, but with more numerous and more distinctly granulated rays.

Loc. Baboa Hill.

Nucula Baboensis. Transversely oval, convex, smooth ?; lunette sunk; beaks nearest the anterior side. Length $\frac{3}{4}$ inch, width 1 inch.

Nearly resembling *N. Bowerbankii* (Geol. Trans., 2d series., vol. v. 136. Pl. 8. f. 11.) but not truncated or pointed below the lunette.

Loc. Baboa Hill.

Pecten lævi-costatus. Short, smooth, radiated; radii about 20, large, equal to the spaces between them; ears large; inside furrowed. Length 1 inch 4 lines.

Length a little less than the width, but the ears enter so much into the sides that they confine the beaks into a small angle, and make the form appear more transverse than it really is.

Loc.

Ostrea callifera. (Lam. Hist. Nat. vol. vi. p. 218. Deshayes, Coq. Fossiles des Env. de Paris, vol. i. 339. Pl. LI., f. 1, 2.) ? A very ponder-

ous shell, with only a shallow cavity for the animal. Length $3\frac{1}{2}$ inches, width $2\frac{3}{4}$ inches, thickness of the shell above an inch and a quarter.

Loc. Wagé-ké-Pudda.

Ostrea orbicularis. Orbicular, plaited; both valves convex; plaits angular, repeatedly forked; surface imbricated. Length and width about two inches, resembling *O. Flabellulum*, but more regularly and finely striated. See p. 323.

Loc. Luckput.

Neritina grandis. Short-conical, smooth; spire concealed; aperture very large; base convex, its margin rounded. Diameter 3 inches, height $1\frac{1}{2}$ inch.

This resembles *N. Schmidelliana*, but has a larger aperture in proportion and a less excentric apex; it is also higher. The specimen is little more than a cast, and does not exhibit the edge of the inner lip, but still it shows the attachment of the ligament projecting from the lower surface, and that the aperture occupied more than half the base.

Loc. Wagé-ké-pudda.

Globulus obtusus. Globose, with a very short spire; whorls about 6; aperture ovate-elongated, pointed above; umbilicus open, narrow. Height 1 inch, diameter the same.

The short spire of 5 whorls gives this shell a very blunt aspect.

Loc. Baboa Hill.

Turbinellus bulbiformis. Short-fusiform, smooth; spire pointed; whorls 6, flattened in the middle; aperture narrow, pointed at both ends. Height above 7 inches, diameter 5 inches.

Resembles *T. Napus*, but has a more elongated spire.

Loc, Wagé-ké-pudda.

Cypræa depressa. Obovate, with a blunt spire and a flattened space across the middle of the back. Length $3\frac{1}{2}$ inches width 2 inches 7 lines.

This being only a cast, we can give but a very imperfect description.

Loc. Baboa Hill.

Nummularia acuta. Depressed, sides conical, decreasing in proportional height by age; when young radiated, when full-grown granulated; volutions and septa numerous; edge sharp. Diameter 5 lines, thickness $1\frac{1}{2}$ line.

Distinguished from most other species of Nummularia by the conical form of the sides.

Loc. Luckput.

Nummularia obtusa. Irregularly orbicular, thick, smooth, sides flattened: margin rounded; volutions and septa very numerous. Diameter of

the largest individual 10 lines, thickness nearly five lines. A remarkably thick species.

Loc. Wagé-ké-pudda.

Lycophris Ephippium. Orbicular, depressed, curved so as to resemble a saddle, with a gently elevated umbo on each side; margin thick, obtuse, with a narrow waved keel in the middle; grains on the surface small and equal. Diameter 1½ inch, thickness 3 lines.

Lycophris dispansus. Lenticular, thick, with a very thin, expanded, sharp-edged margin; grains on the surface largest in the centre of the disk. Diameter ½ an inch.

These two fossils may possibly be different stages of growth of the same species; for there occur along with them many curved plates which are intermediate in form. The grains on the surface are the projecting extremities of internal columns, not merely granulations in the substance of the fossil, as in some species of Nummularia. The internal structure is totally different from that of Nummularia, as it is only on the inner surfaces of the two plates that any appearance of a spiral or concentric series of cells can be traced. In p. 321 these fossils are assigned to the genus *Orbitolites*.

Loc. Both species very abundant at Baboa Hill and Wagé-ké-pudda.

Fasciolites (Parkinson) *elliptica.* Elliptical with blunt extremities, bands curved. Length 5½ lines, diameter 3 lines.

Several species of this genus occur in the tertiary formations of Europe, but they are longer in proportion to their thickness.

Loc. Wagé-ké-pudda and Baboa Hill.

Echinus dubius. Orbicular, depressed; areæ granulated, concave, and nearly free from grains along the middle; the larger furnished with two rows of tubercles near each side; the lesser with one row on each side; pores of the ambulacra in numerous, arched rows. Diameter about 3 inches, height about 1¼ inch.

This has apparently imperfect tubercles, and is much longer than *Cidarites variolaris*, Brongn., which however it much resembles.

Loc. Baboa Hill and Wagé-ké pudda.

Galerites pulvinatus. Orbicular, depressed, spheroidal, covered with minute tubercles. Ambulacra obscure beneath, crossed by grooves above. Diameter 3¼ inches, height 1 inch 10 lines.

A species much like *G. depressus*, Lam., but more convex and ten times the size of it.

Loc. Baboa Hill.

Clypeaster affinis. (Goldfuss, p. 134. t. 43, f. 6.)? Our specimen appears to be more orbicular than the *C. affinis* of Goldfuss, but it is too

imperfect to be determined,—the posterior half being nearly all broken away. Length about $2\frac{1}{4}$ inches, width 2 inches, height 1 inch.

Loc. Baboa Hill.

Clypeaster varians. More or less obovate, hemispherical; base slightly concave in the middle; ambulacra elongated; anus transverse. Length $2\frac{1}{2}$ to 3 inches, breadth 2 to $2\frac{1}{2}$ inches, height $1\frac{3}{4}$ to 2 inches.

C. Bonei of Munster, (Goldfuss, 131. t. 41. f. 7.) resembles this, but is more depressed, and has a circular anus.

Loc. Baboa Hill and Wagé-ké-pudda.

Spatangus obliquatus. Gibbose; emarginate at the front; behind obovate, rather acuminated, and truncated obliquely upwards. Ambulacra deeply sunk in 3 large and 2 smaller ovate pits; base slightly convex. Length $2\frac{1}{2}$ inches, width 2 inches, height $1\frac{1}{2}$ inch.

Strongly resembling *S. Bucklandii*, (Goldfuss, 154, t. 47. f. 6.) it is however much larger, and has unequal ambulacra. In this and the allied species with concave ambulacra there is a reticulated band surrounding the ambulacra, which deserves attention.

Loc. Baboa Hill.

Spatangus acuminatus. (Goldfuss, 158. t. 49. f. 2.)? Our specimen is not quite so much elevated posteriorly as the figure given by Goldfuss, neither is it quite so wide; in both these circumstances it approaches to *S. lacunosus*; but it is laterally crushed, which may account for the difference. Length $1\frac{1}{4}$ inch, width nearly the same, height 10 lines.

Loc. Baboa Hill.

Spatangus elongatus. Elongated, ovate, depressed; front emarginate; base convex; ambulacra concave, with two of the rows of pores nearly central; apex excentric; mouth remote from the margin. Length nearly $2\frac{1}{2}$ inches, width $1\frac{3}{4}$ inch, height 1 inch.

The two posterior ambulacra and the posterior portion of the shell are broken; the description is therefore incomplete.

Loc. Baboa Hill.

Clypeaster oblongus. (*C. scutiformis* ? Lam.) Oblong, subpentagonal, convex above, concave beneath; ambulacra very broad, obtuse. Length $2\frac{3}{4}$ inches, breadth above 2 inches, height 7 lines.

The specimen is too much mutilated to show the anus. It is more pentagonal than *C. scutiformis*, to which we have before referred it.

Tertiary Formation. Loc. Between Joongrea and Kotra.

Clypeaster depressus. Pentagonal, much depressed; ambulacra oval; anus very near the margin. Length in the oldest individual about 2 inches, breadth rather less, height about $\frac{1}{2}$ inch.

This differs from *C. Laganum* in the position of the anus, which in that

species is half-way between the mouth and the margin, in the greater size of the papillæ, and in being much thinner.

Tertiary Formation. Loc. Soomrow.

(Fossils from the Tertiary Formations, Cutch.)

Serpula ? recta. An oval, free, slightly-waved shelly tube, which we have provisionally called a *Serpula*, although it is more like the tube of a *Teredo;* but it appears to have been formed in loose sand. Diameter $\frac{3}{4}$ inch.

Loc. near Kotra.

Siliquaria Grantii. Spirally striated ; striæ crossed by numerous cracks ; fissure composed of a series of oval pores. It differs from the recent *S. anguina* only in the smallness of the pores which form the fissure.

Loc. Borders of the Runn.

Balanus sublævis. Subcylindrical with curved valves, nearly smooth. Operculum ? Diameter 1 inch, height 9 lines. Parasitic upon shells.

Loc. Soomrow.

Corbula trigonalis. Trigonal, with the front rounded, gibbose, antiquated ; valves nearly equal, posterior side truncated obliquely with a carina upon each valve, and pointed ; umbones equal, central. Length 6 lines, width 8 lines ; but these proportions vary.

Loc. Borders of the Runn.

Corbula rugosa. (Lam. vol. v. 497.) This differs from the last in being a much wider shell, with more regular and prominent laminæ upon the surface. Length $2\frac{1}{2}$ lines, width $3\frac{1}{2}$ lines.

Loc. Borders of the Runn.

Tellina exarata. Ovate, compressed, ornamented with many erect concentric laminæ ; the posterior extremity pointed, much bent. Length nearly $\frac{3}{4}$ of the width, which is nearly 2 inches.

Strongly resembling *Tellina virgata*, (Lam. Hist. Nat. vol. v. 52.) but wider and more bent.

We have ventured (contrary to our usual custom) to complete the surface of this shell, although much has been lost from the specimen.

Loc. Soomrow.

Venus granosa. Obovate, truncated, posteriorly convex, ornamented with erect concentric laminæ, crossed by numerous striæ which cut these (near the margin) into rounded grains ; lunette broad, pointed, convex ; beaks nearest the anterior extremity. Length $1\frac{3}{4}$ inch, width more than 2 inches.

This belongs to the same family of *Venus* as *V. Corbis*, and *V. puerpera*, and is scarcely distinguishable from *V. puerpera*, *β*. (Lam. Hist. Nat. vol. v. 585.)

Loc. Soomrow.

Venus cancellata. Obovate, approaching orbicular, gibbose, ornamented with erect concentric laminæ, and many longitudinal striæ ; lunette wide, pointed, convex ; beaks nearest the anterior extremity. Length 1¾ inch, width 1 inch 11 lines.

This resembles the last, except that it is rounder, with thinner laminæ, which are not cut into round grains.

Loc. Soomrow and Kotra.

Venus non-scripta. Tranversely oval, convex, smooth, concentrically undulated ; lunette elongated, pointed, concave ; beaks nearer the anterior extremity. Length 1 inch 4 lines, width 1¾ inch.

A smooth and thin shell, with little of the aspect of a Venus.

Loc. Soomrow.

Pullastra ? virgata. Transversely oval, elongated, decorated with smooth concentric ridges ; beaks nearest the anterior extremity. Length 13 lines, width 1 inch 7 lines.

Several recent species of *Pullastra* are like this, but no described one appears to be identical with it.

Loc. Soomrow.

Cardita intermedia, (Lam. Hist. Nat., vol. v. part 1. 23. Brocchi. vol. ii. 520. t. 12, f. 15.) ? This strongly resembles several species of *Venericardia*, Lam.

Loc. Soomrow.

Cardium triforme. Orbicular, ventricose, longitudinally striated ; anterior side covered with round granules formed by decussating striæ ; the posterior side crossed by oblique sets of reflected ridges. Length and width 1 inch 4 lines.

Somewhat resembling the recent *Cardium æolicum.*

Loc. Soomrow.

Arca radiata. Transversely elongated, oblique, rather convex, radiated ; radii elevated, furrowed ; beaks almost close, nearest the anterior side.

Length, 7 lines, width 1 inch.

Loc. Soomrow.

Arca tortuosa ? Linn. This is only a fragment, and what there is, seems to differ from the recent *Arca tortuosa* in the degree of curvature,

Loc. Soomrow.

Pecten Somrouensis. Obovate, convex, radiated; radii about 24, squamose, subdivided, in one valve into 3, in the other into 5 : ears unequal, striated, and squamose. Length 2 inches 2 lines, width nearly 2 inches.

In form this *Pecten* approaches to *P. varians,* but in the structure of the surface it is like *P. plebeius* of the Crag, and many recent species.

Loc. Soomrow.

Pecten articulatus. Orbicular, with pointed beaks, depressed, radiated; radii about 28, simple, rounded, crossed by distant scales; ears large, striated, and squamose. Length in an old specimen about 1 inch 8 lines, width 1 inch 6 lines.

The radii when the scales are worn off appear jointed.

Loc. Bank of the Runn.

Gryphæa globosa, (M. C. t. 392, *Ostrea vesicularis,* Lam. Hist. Nat. vol. vi. part I. p. 219. Cuv. and Brongn. Env. de Paris, 383, t. 3. f. 5. *Podopsis gryphæoides,* Lam. Hist. Nat. vol. vi. part 1. 195).

This exactly agrees with old specimens found in the chalk of Norfolk.

Loc. Kotra.

Ostrea angulata. Suborbicular, arched, compressed, plaited; plaits angular, numerous, branched towards the margin; laminæ of increase regular, distant, raised at their edges. Length about $1\frac{1}{4}$ inch, width the same.

Loc. Kotra.

Ostrea Flabellulum, (M. C. t. 253. Lam. Hist. Nat. vol. vi. part 1. 215. *Chama plicata,* Brander, 84 and 85.). The identity of this oyster with the *O. Flabellulum* of the tertiary formations of Europe is unquestionable.

Loc. Cheeosir.

Ostrea tubifera. Orbicular; laminæ of increase thick, raised into a few large, nearly erect tubes arranged in about 6 rows. Diameter 2 inches.

Loc.

Ostrea Lingua. Much elongated, smooth, approaching to even; upper valve flat or concave, the other very convex; squamoso-fimbriated at the edges. Length $2\frac{1}{2}$ inches, width $1\frac{1}{2}$ inch.

So variable are *Ostreæ* in form and so much do the species resemble each other, that it is hardly possible to define some of them clearly. That before us is very like *O. tenera* (M. C. t. 252, f. 2 and 3.), yet in

the depth of the attached valve it approaches to *O. Meadii* (M. C. 252, f. 1 and 4.), but is not waved like that.

Loc. near Joonagrea and Kotra.

(Fossils from the Tertiary Formations, Cutch.)

Bulla lignaria, Linn. This agrees perfectly with the recent species as far as we can ascertain from specimens which are not perfect; but it is quite distinct from both the fossil shells described by Deshayes under the same name.

Loc. Soomrow.

Natica obscura. Globose, umbilicate; spire small, pointed; whorls about 5, convex, flattened, and ornamented at the upper edge with fine diverging plaits; umbilicus partly filled with a semi-cylindrical, obliquely-truncated callus. Height 1¼ inch, diameter the same.

Nearly related to *N. Epiglottina*, Lam., but distinguished by the flattened upper margins of the whorls; and to *Nerita canrena* of Brocchi, vol. ii. 296.

Loc. Soomrow.

Natica callosa. Obliquely depressed; spire small, hardly projecting; umbilicus covered by the thickened and expanded inner lip: aperture very large. Height 2 inches, diameter 1¾ inch.

A very distinct species.

Loc. Soomrow.

Globulus ? anguliferus. Oblong, obliquely striated: spire produced; whorls about 4, with their sides and upper edges flattened; umbilicus open, rather large. Height and diameter ¾ inch.

The elevated lines or striæ advancing towards the aperture as they descend the sides of the whorls form a peculiar character. The aperture appears to be small.

Loc. Borders of the Runn.

Solarium affine. Convex above, flattish beneath, marked with diverging striæ on both sides; whorls 4 or 5, with a deflected entire carina, above which are 4 furrows placed at nearly equal distances, and below, 2 furrows near the carina, and 2 near the umbilicus, which is large, with a crenated edge. Diameter 1½ inch, height ½ inch.

Perfectly distinct from *Solarium perspectivum*, which it somewhat resembles.

Loc. Soomrow.

Trochus cognatus. Conical with straight sides; whorls numerous, or-

namented with several rows of granules, which sometimes (especially towards the apex) are united by elevated lines, and a row of tubercles upon the inferior edges of the upper whorls, succeeded by 2 rows upon the middle volutions, and crenated ridges of slight elevation on the rounded border of the lowest whorls ; base flat, concentrically furrowed, containing a thick plait within

Like *T. maculatus* ; height 2 inches, diameter of the base nearly the same.

Loc. Soomrow.

Turritella angulata. Turrited, conical ; whorls convex, decorated by about 7 carinæ, of which the lowest but one is much the most prominent. Height 1⅓ inch, diameter 8 lines.

Loc. Soomrow.

Turritella assimilis. Turrited, whorls convex, ornamented with 6 or 7 carinæ, of which 2 or 3 are obscure, the 2d and 5th being prominent. Height 1⅛ inch, diameter 5 lines.

A smaller, narrower species than the last.

Loc. Soomrow.

Terebra reticulata. Subulate ; sides of the whorls flat, cancellated ; a narrow upper portion of each whorl divided from the lower in the form of a band by a ridge and furrow ; beak short, curved.

In some specimens the transverse or spiral lines are less conspicuous, particularly on the band and the upper half of the whorl.

Loc. Soomrow.

Cerithium rude. Subulate, with curved sides, ribbed and furrowed ; ribs numerous, cut across by about 5 square furrows, of which the uppermost is distant from the suture ; whorls 10 or 12, nearly flat, with an obtuse varix between each—the last varix very prominent ; aperture nearly round, with a canal at the upper angle ; inner lip thick, with a callus at the top ; beak broken. Height 2 inches 8 lines, diameter about 8 lines.

Loc. Soomrow.

Cerithium corrugatum. Subulate, ribbed and coarsely striated ; ribs numerous, arched, and prominent, crossed by deep striæ ; whorls 8 or more, rather convex, with a distinct varix upon each.

This has much of the contour of an elongated Fusus. The lip and beak are wanting in the only specimen found.

Loc. Soomrow.

Fusus? granosus. Short-fusiform, ribbed ; ribs about 12 upon each whorl, divided into grains by 6 or 7 transverse ridges, convex ; spire half the length of the shell ; beak suddenly contracted. Height 4 lines.

A pretty shell, much resembling some species of *Nassa* which occur in the Crag.

Loc. Soomrow.

Fusus læviusculus. Short, fusiform, ribbed, and striated; ribs irregular, mostly very short; whorls 6, angular; base conical; beak short. Height 10 lines, diameter 5 lines.

Loc. Soomrow.

Fusus nodulosus. Fusiform, elongated, ribbed and strongly striated; ribs short, broad, about 8, in the middle of each whorl; whorls 6 or 7, concave above, convex below; beak contracted.

Loc. Soomrow.

Fusus (Murex ?) hexagonus. Short-conical, with an elongated beak, 6-angled; whorls about 6, with 6 ribs on each, which form the angles of the spire, and are crossed by 3 strong ridges upon the spire, thickened where they cross, convex; beak suddenly contracted.

Loc. Soomrow.

Ranella Bufo. Conical, with 2 rows of thin expanded varices and several ribs, the whole crossed by 3 or 4 prominent and several intermediate thin ridges; whorls 7 or 8, convex; varices obtuse at their edges; aperture oval; beak short, oblique. Height 1 inch 4 lines, diameter 1 inch.

Nearly resembles *Ranella bituberculata* of Lamarck.

Loc. Soomrow.

Rostellaria rimosa, (M. C. 91. f. 4, 5, 6, *Strombus cancellatus*, Lam. Hist. Nat. vol. vii. t. 212 ?)

The fragment we have before us, is firmly imbedded in the stone, and we are not able to clear the lip so as to ascertain whether it be striated like the lip of the recent *Strombus cancellatus*, Lam., or smooth and thickened as in *Rostellaria rimosa* and *R. Fissurella*, Lam., &c.; of all these, the species nearest to the fossil is *R. rimosa* of the London Clay, which is easily distinguished from *R. Fissurella*, Lam., of the Paris Basin, by being striated all over, and having the canal continued nearly to the apex of the spire, but not curved back. From *Strombus concellatus*, Lam., this fossil is distinguished by having a tumid varix upon the last whorl, a character also of *Rostellaria rimosa*, and we are consequently induced to refer the Cutch shell to it rather than to *Strombus cancellatus*.

Linnæus and his immediate followers did not distinguish between the recent and fossil shells, although the recent one (*Strombus decussatus*, Lam.) has the lip striated within, and is placed by Lamarck in another genus, while Deshayes in the " Coquilles fossiles des environs de

Paris," unites the French fossil and the two English ones under one name, although they are perfectly distinct; probably he has not examined English specimens. We find the characters very constant, and easily observed when once pointed out. The analogous shells of Bordeaux are equally distinct. About the same size as *R. rimosa*, M. C., from Barton.

Loc. Soomrow.

Rostellaria rectirostris. (Lam. Hist. Nat. vol. vii. 192.) The elongated form induces us to refer this fossil to the recent *R. rectirostris*, in preference to any other species.

Loc. Soomrow.

Strombus deperditus. Turbinate, tuberculated, and transversely striated; tubercles united by a slight carina gradually increasing in size; lip thickened, produced above into a short pointed lobe. Height $2\frac{1}{4}$ inches, diameter 1 inch 4 lines including the wing.

Much like *Strombus Gallus*, Linn., and *S. bituberculatus*, Lam., but the tubercles are of an equal size on the last whorl and not much larger than on the spire. The aperture is not much dilated, so that the wing is rather small. It appears to be a very common shell in the Runn, but perhaps there are several species, as many of the specimens are so firmly attached to the stone, and so much concealed, that the distinguishing marks cannot be traced.

Loc. Soomrow.

Strombus nodosus. Turbinate, elongated, tuberculated, transversely and longitudinally striated; tubercles equal, numerous, prominent, obtuse. Height $1\frac{3}{4}$ inches.

Distinguished by the rounded tubercles, of which there are about 12 to each whorl—and the elongated spire.

Rare—we have seen but one specimen and that is very imperfect.

Loc. Soomrow.

Cassis (*Cypræcassis*, Stutchbury,) *sculpta.* Ovate, transversely sulcated; aperture narrow, the outer lip plaited, the inner smooth. Height $1\frac{3}{4}$ inch, diameter 1 inch.

Strongly resembling *Cassis* (*Cypræcassis*, Stutchbury,) *Testiculus* (*Bucc. Testiculus*, Linn.), but smoother, and with a narrower aperture.

Loc. Soomrow.

Turbinellus affinis. Subfusiform, swelled in the middle, ornamented with many transverse ridges and a row of flatted tubercles near the upper margin of each whorl; beak produced transversely, ribbed; columella 5-plaited. Height 4 inches, width 2 inches.

Very nearly related to *Turbinellus Scolymus*, Lam., but it is more elongated, has smaller tubercles, and 5 not 3 plaits on the columella.

Loc. Soomrow.

Mitra scrobiculata (Brocchi, vol. ii. 317. t. iv. f. 3.) ? This is the same as the fossil found at Piacenza.

Loc. Soomrow.

Mitra fusiformis. Fusiform, pointed, striated; striæ distant, deep, punctated, suture entire; columella with 4 plaits. Height 2 inches, diameter 9½ lines.

Somewhat resembling *Mitra adusta* of Lamarck.

Loc. Soomrow.

Volupta jugosa. Fusiform, pointed, transversely striated, costated; costæ many, rounded, terminating in points above the suture; aperture elliptical, elongated; columella with 3 plaits. Height 2½ inches, diameter 1¼ inch.

This differs from *V. Magorum* of Brocchi, in the form of the ribs, and the small number of plaits upon the columella, and from *V. costata*, (M. C. t. 290.) in the form and in the greater number of the ribs.

Loc. Soomrow.

Voluta dentata. Turbinate, striated, spire short, conical, pointed; whorls crowned with tubercles which surround a concave space; aperture elongated; the outer lip thick, crenato-dentated within. Height 1 inch 7 lines, diameter 1 inch.

Loc. Soomrow.

Cypræa humerosa. Obovate, depressed with 3 protuberances upon the back, and one on each side. Length 2 inches, width 1½ inch.

Loc. Soomrow.

Cypræa Prunum. Oval, ventricose; aperture narrow, slightly curved with about 20 teeth on each side; base convex; beak small, not much produced; a very even shell. Length nearly 2 inches, width 1¼ inch.

Loc. Eyerau.

Cypræa digona. Ovate, ventricose, slightly depressed; base flattened on each side; beak expanded, prominent, with sharp edges; teeth on each side the aperture, above 20. An obscurely-marked species. Length 13 lines, width 9½ lines.

Loc. Soomrow.

Cypræa nasuta. Ovate-elongated, ventricose; beak projecting, large; posterior extremity of the lip produced; apex of the spire sunk. Length 10 lines, width 6 lines.

Loc. Soomrow.

Terebellum obtusum. Ovate, much elongated; spire 2 or 3 whorls, obtuse.

Length about 2 inches, width 6 lines.

This is more like the recent *T. subulatum* than the fossil *T. fusiforme.*

Loc. Soomrow.

Oliva Pupa. Elongated, subcylindrical, with a produced pointed spire, a broad smooth band at the base, and a slightly-plaited callus on the columella. Length 1 inch 9 lines, width 8 lines.

Loc. Soomrow.

Conus brevis. Short-conical; spire flat, with a produced apex marked with 4 concentric striæ decussated by the lines of growth; base ornamented with several small, rather distant ridges. Height 1¼ inch, diameter 1 inch.

Imperfect specimens are found, more than double the above diameter.

Loc. Soomrow.

Conus militaris. Conical, elongated, slightly contracted towards the edge of the spire, coloured by many triangular spots arranged in zigzag rows; spire flat, upper surfaces of the volutions concave; base nearly smooth. Height 1½ inch, diameter 11 lines.

This shell and the following retain traces in a remarkable manner of the original colouring.

Loc. Soomrow.

Conus catenulatus. Conical, elongated, coloured with transverse rows of white spots upon a dark ground—spire flat, elevated in the middle, concentrically striated, mottled with white, the edge sharp; the base obscurely furrowed. Length 1¼ inch, width 8 lines.

Loc. Soomrow.

Conus marginatus Conical, much elongated; spire conical, short, surrounded by an obtuse ridge from its base to its apex; base of the shell striated. Length 1½ inch, width 8 lines.

Loc. Soomrow.

IX.—*On certain Meteorological Phænomena in the Ghâts of Western India.**—*By Col.* Sykes, *F. R. S.*

In the proceedings of the Physical Section at the meeting at Newcastle, the incidental mention of the annual fall of very many feet of

* From the Report of the Ninth Meeting of the British Association for the Advancement of Science for 1839.

rain in certain localities of India, instead of a few inches, as is the case in Europe, caused, I was told, some surprise, and the expression of a doubt whether the fact had been ascertained with sufficient precision, and by competent persons. I was not present on the occasion alluded to, but the doubt having been brought to my notice subsequently, I lost no time in applying to a friend to procure for me the official meteorological records kept by order of the government of Bombay at the convalescent station of Mahabuleshwar, which records I knew would afford sufficient evidence to remove all doubts, at least so far as related to one locality; and I have now the pleasure of submitting the abstract of the Meteorology for 1834; the observations being made by Dr. Murray, the medical officer in charge of that station. The station is situated lat. 17° 58′ 53″ N. and long. 73° 29′ 50″ W., near the western scarp of the Ghâts, or mountain chain extending from Surat to Cape Comorin, and varying from 1000 to 8000 feet in height. The elevation of the table-land at Mahabuleshwar averages 4500 feet. The temperature of a spring is 65·5 Fahr., and the mean temperature of the air for three or four years is nearly the same. There is a good deal of forest along the Ghâts, but in belts and patches, so that the wood can have little effect on the phænomena which I am about to describe. In this table-land is the source of the celebrated Kistnah river, which runs across the peninsula.

The following table shows the state of the thermometer, fall of rain, &c., at the station:

Months.	Mean Temperature.	Mean Maximum.	Mean Minimum.	Mean Variation.	Fall of Rain in Inches.	Direction and force of the Wind. A. M.	Direction and force of the Wind. P. M.
January	65·7	71·2	60·2	11·	—	E. light.	E. N. E. & W. light.
February	67·5	73·7	61·3	12·4	0·25	E. N. E. light.	W. N. W. light.
March	74·0	81·7	66·4	15·3	—	N. E. light.	W. & N. W. fresh.
April	74·4	82·2	66·7	15·5	Two light showers	N. E. light.	W. light..
May	73·9	80·6	67·3	13·3	0·16	W. N. W. & S. W. fresh.	W. N. W. & S. W. fresh and strong.
June	66·3	69·3	63·4	5·9	32·03	S. W. high & fresh.	S. W. high & fresh.
July	64·9	65·6	63·2	3·4	118·60	S. W. strong.	S. W. strong.
August	65·3	66·9	63·8	3·1	75·91	S. W. high.	S. W. high.
September	65·0	66·4	63·6	2·8	65·97	S. W. fresh.	S. W. fresh.
October	65·5	69·4	61·7	7·7	9·29	N. E. fresh.	N. E. & S. W. light E. N. E. fresh.
November	63·5	69·5	57·5	12·0	—	E. N. E. high.	E. N. E. fresh.
December	62·3	68·4	56·2	12·2	One light shower.	E. N. E. fresh.	E. N. E. & W. light.
Mean	67·3	72·1	62·6	9·5	302·21		

Hence it appears that the mean temperature of 1834 was 67·3 Fahr., that of the hottest month (April) 74·4, that of the coldest month (Dec.) 62·3 ; the mean maximum (April) 82·2, and the mean minimum (Dec.) 56·2. The mean variation was greatest in April, 15·5, and least in September, 2·8 ; and the mean variation for the year was only 9·5. The fall of rain was prodigious, being equal to 25 feet 2 inches, and this enormous mass of water fell almost entirely in the months of June, July, August and September. General Lodwick, late president at the court of Sattarah, who transmitted to me the official register, says, "I send to you a copy of Dr. Murray's meteorological table. The inches of rain are no less than 302·21. This will astonish the philosophers, but it would do more than astonish them, had they the opportunity of seeing and hearing the rain fall in torrents through a dense fog or mass of clouds which lie upon the ground for perhaps six weeks together, with a temperature by no means cold, and with little variation." The excessive fall of rain along the line of the Ghâts does not seem to be incompatible with health, for the military detachment stationed permanently at Mahabuleshwar is not characterized by any unusual sickness; and the statistical returns of the population on the hills are as healthy as those of the table-lands to the eastward. It now remains to notice some striking facts on the western side of the peninsula. The quantity of rain that falls differs exceedingly between the coast, the Ghâts within fifty miles of the coast, and the table-land eastward of the Ghâts. The mean at Bombay is 80·69. Dr. Murray shows a fall in the hills, at the elevation 4500 feet, of 302 inches, and my records at Poonah give a mean annual fall of 23·43 inches. The solution of the causes of the anomalous fall of rain does not offer any considerable difficulties. The enormous mass of vapour taken up from the Indian Ocean on approaching India, does not appear to have its upper surface at a greater elevation than five or six thousand feet, while the stratum is of great thickness; and I can bear testimony to its lower surface being below fifteen or eighteen hundred feet. The temperature of the air over the equator is necessarily very high, and its capacity for the support of aqueous vapour is proportioned to its temperature. The vapour is converted into rain, as it is driven into air of lower temperature ; and, as the temperature gradually lowers proceeding to the north, and approaching the land, it follows, that out at sea, and along shore, with equal supplies of vapour, a less quantity of it would be converted into rain eastward. With respect to the prodigious fall at Mahabuleshwar and along the Ghâts, it may be accounted for by the supposition that the monsoon vapour being of low elevation and high temperature, is driven against the mural faces, and up the chasms

of the Ghâts, into higher regions, and into a colder atmosphere, and is thus immediately converted into rain. The paucity of rain forty or fifty miles eastward of the Ghâts, results from the comparatively small quantity of vapour which escapes from the cold belt of air through which it is forced to pass in the hills.

X.—*Proceedings of the Madras Literary Society and Auxiliary of the Royal Asiatic Society.*

Thursday Evening, 1*st October* 1840.—A. D. Campbell, Esq., *President of the Committee of Papers, in the Chair.*

The following works, presented to the Society, were laid before the meeting, and thanks voted to the donors :—

Journal of the Royal Asiatic Society of Great Britain and Ireland, No. 11—By the Society.

Journal of the Asiatic Society of Bengal, No. 15—By the Society.

The India Journal of Medical and Physical Science, No. 57—By the Editor

The India Review and Journal of Foreign Science and the Arts, No. 53—By the Editor.

The Chinese Secret Triad Society of the Tien-ti-Huih, 22 copies—By the Royal Asiatic Society of Great Britain and Ireland.

Thursday Evening, 5*th November* 1840—J. Cadenhead, Esq. *in the Chair.*

The following works, presented to the Society, were laid on the table, and thanks voted to the donors :—

The Vishnu Purana, 4 copies—By the Madras Government.

Journal of the Asiatic Society of Bengal, Nos. 16 and 17—By the Asiatic Society.

Corbyn's India Review and Journal of Foreign Science and the Arts, for September and October 1840—Nos. 54 and 55—By the Editor.

Corbyn's India Journal of Medical and Physical Science, Nos. 58 and 59—By the Editor.

McClelland's Calcutta Journal of Natural History, Nos. 2 and 3—By the Editor.

The Chinese Repository for May and June 1840—By the Editor.

Thursday Evening, 3d December 1840—*Doctor* R. WIGHT, *in the Chair.*

The following works, presented to the Society, were laid on the table, and thanks voted to the donors :—

Journal of the Asiatic Society of Bengal, No. 18—By the Asiatic Society.

The India Journal of Medical and Physical Science, No. 58—By the Editor.

The India Review and Journal of Foreign Science and the Arts, No. 55—By the Editor.

The Chinese Repository, Nos. 9 and 10, January and February, 1840—By the Editor.

Horary Meteorological Observations made agreeably with the suggestions of Sir John Herschel,

1*st.—At the Madras Observatory on the* 21*st September* 1840.

1840.	Time.	Barometer.	Thermometer. Dry.	Thermometer. Wet.	Direction of wind.	Remarks.
Sept. 21	6 A.M.	29,864	79,2	0,6	s s w	Breeze wind, cloudy.
	7	29,876	79,7	0,4	s w	Do. do. zenith clear
	8	29,900	81,7	0,7	s e	Do. do. do.
	9	29,912	83,8	2,9	s	Fresh wind, do.
	10	29,900	85,3	4,6	w	Do. do. flying clouds.
	11	29,898	86,4	6,5	w	Do. do. do.
	12	29,864	88,2	8,7	w	Do. do. do.
	1 P.M.	29,834	87,5	7,1	e	Do. do. do.
	2	29,810	88,0	6,5	e	Do. do. do.
	3	29,790	87,1	5,6	s e	Strong wind do. and thunder.
	4	29,818	83,2	6,2	n n w	Cloudy and very loud thunder with drizzling rain.
	5	29,778	79,6	3,6	s w	Cloudy.
	6	29,804	80,0	2,7	——	Calm, clear.
	7	29,815	80,2	2,2	s e	Very cle r.
	8	29,840	80,3	2,3	s e	Do. do.
	9	29,868	80,2	1,9	——	Calm, clear, lightning and dew.
	10	29,882	79,8	1,6	——	Do. zenith clear, do- do.
	11	29,886	80,8	2,1	——	Do. flying clouds do. do.
	12	29,870	82,3	2,8	s	Gentle wind fl. cl. overcast lightning and thunder.
	1 A.M.	29,836	79,9	1,9	s	Do. do. cloudy thunder and lig.
	2	29,834	79,9	2,3	s	Do. do. do. loud thunder and vivid lightning.
	3	29,812	76,9	1,7	s	Do. do. do do. do. do.
	4	29,814	77,3	2,3	s	Do. do. do. thunder and lightng.
	5	29,820	77,0	2,6	s s w	Do. do. do.
22	6	29,832	76,9	1,1	s w	Do. do. do.
	7	29,874	77,0	1,7	——	Calm do.
	8	29,880	79,7	3,5	s w	Fresh wind do.
	9	29,876	81,0	2,3	w	Do. do. do.
	10	29,880	83,8	4,3	w	Do. do. zenith clear and some haze in south.
	11	29,870	85,1	6,1	w	Do. do. haze.
	12	29,840	86,1	7,6	w	Gentle wind, clear.
	1 P.M.	29,800	87,8	8,3	e	Gentle breeze, do.
	2	29,774	88,0	8,5	e	Do. do. do.
	3	29,764	88,2	8,2	w s w	Gentle wind, flying clouds.
	4	29,758	86,5	5,2	s w	Flying clouds.
	5	29,756	84,8	3,8	s w	Do. do. thunder.
	6	29,765	84,0	3,4	s w	Cloudy.

2*d*.—*At the Trevandrum Observatory at the Winter Solstice* 1840.

Date.	Hour.	Newman's Portable bar. corrected for temp. 32° and for capillarity.	Standard thermometer.	Depress. of wet bulb. thermometer.	Dew point.	Direction of wind.	Velocity of the wind.	Solar radiation.	Clouds, aspect of the sky and remarks.
Dec. 21	6 A.M.	29·756	68·6	8·0	55·00	N.	6	No observations—On account of Actinometer being out of order.	Sky clear gentle wind.
	7	·782	68·4	8·1	54·50	do.	4		Do. do.
	8	·803	73·5	9·8	57·30	N. by E.	5		Do. do.
	9	·818	77·8	13·4	55·50	NE. by N.	5		Light clouds rising up do.
	10	·822	80·9	16.3	53·40	NE. by E.	3		Do. do.
	11	·802	82·4	17·5	52·90	NN. W.	4		Sky rather clear do.
	Noon.	·771	83·5	17·0	55·40	do.	3		Do. do.
	1 P.M.	·747	84·3	17·2	56·10	N. by E.	1		Do. wind hardly perceptible.
	2	·722	84·8	17·7	55·70	SE.	3		Do. gentle wind.
	3	·710	84·0	15·9	58·30	S.	4		Light clouds do.
	4	·709	82·8	15·5	57·60	SS. W.	3		Do. do.
	5	·722	81·5	13·7	59·40	S.	3		Do. do.
	6	·744	79·5	12·4	59·40	SS. W.	2		Zenith clear, rest cloudy, wind just perceptible.
	7	·769	78·5	10·6	61·56	W.	1		Sky clear light air.
	8	·794	75·4	9·4	60·17	ES. E.	1		Do. do.
	9	·808	74·9	9·2	60·00	SE.	2		Cumuli about horizon rest cl. do.
	10	·811	71·0	6·3	60·77	E.	2		Do. do. do.
	11	·804	69·4	5·4	60·60	do.	3		Sky clear gentle wind.
	Mid.	·792	68·9	2·0	65·73	do.	3		Do. do.
„ 22	1 A.M.	·782	68·0	1·9	64·96	——	—		Do. calm.
	2	·766	67·0	3·9	60·62	E.	3		Do. cold wind.
	3	·748	66·3	3·7	60·24	do.	4		Do. do.
	4	·743	65·5	3·9	59·10	do.	5		Do. pleasant wind.
	5	·749	65·6	3·9	59·20	W.	3		Do. gentle wind.
	6	·777	64·9	3·8	58·60	——	—		Do. haze about horizon, calm.
	7	·792	66·2	3·8	60·00	——	—		Do. do, do.
	8	·811	71·8	7·2	60·09	N.	3		Light clouds in the zen. cum. about horizon gentle wind.
	9	·820	77·2	11·0	59·30	do.	1		Sky clear light air.
	10	·810	80·8	14·3	57·40	N. by E.	3		Sky pretty clear gentle wind.
	11	·792	82·5	13·9	60·30	NN. W.	2		Do. wind just percept.
	Noon.	·757	84·4	15·7	59·20	do.	2		Do. do.
	1 P.M.	·730	85·6	18·9	54·20	do.	2		Sky covered with light clouds do.
	2	·706	85·6	14·3	63·53	W.	5		Do. do. pleasant wind.
	3	·693	84·6	14·8	61·24	do.	3		Do. do. gentle wind.
	4	·692	84·3	14·3	61·81	do.	3		Do. do. do.
	5	·703	83·0	12·9	62·97	W. by S.	2		Do. do light air.
	6	·743	80·3	11·0	63·02	S. W.	2		Do. do. do.

No Rain.

The Instruments are the same, and situated exactly as before.

G. SPERSCHNEIDER, *Superintendent*

METEOROLOGICAL REGISTER KEPT AT THE MADRAS OBSERVATORY ; FOR THE MONTH OF JULY, 1840.

Days.	Barometer at 10 A. M.	Barometer at 4 P. M.	Barometer at 10 P. M.	Ther. at 10 A. M.	Ther. at 4 P. M.	Ther. at 10 P. M.	Wet Bulb. 10 A. M.	Wet Bulb. 4 P. M.	Wet Bulb. 10 P. M.	Rain. Sun-rise.	Rain. Sun-set.	Evaporation.	Strength of wind.	Direction of Wind. 10 A. M.	Direction of Wind. 4 P. M.	Direction of Wind. 10 P. M.	Cloudy Max.	Weather. 10 A. M.	Weather. 4 P. M.	Remarks. 10 P. M.
1840	Inch.	Inch.	Inch.	°	°	°	°	°	°											
July 1	29,856	29,758	29,820	88,6	90,3	86,8	10,6	9,1	9,9	......	......	3,665	2	N W	E S E	S E	3	Clear	Clear	Clear—lightning.
2	,840	,748	,820	87,7	90,4	86,3	8,7	10,4	5,8	......	......	......	2	W	E	S E	2	Fl. cl.	Clear	Clear do. Rainbow to the w.
3	,878	,799	,890	88,0	90,0	88,0	8,5	8,5	6,9	......	......	......	2	S E	E N E	S E	3	Fl. cl.	Fl. cl.	Haze do.
4	,908	,800	,892	87,9	88,8	87,9	5,5	8,6	6,0	......	0,017	......	2	E S E	E by S	S E	3	Fl. cl.	Clear	Th. hz. do.
5	,882	—	,844	80,5	—	86,1	7,4	—	6,1	......	......	......	2	N W	—	E	5	Fl. cl.	—	Cloudy do. [and lightning.
6	,846	,743	,818	84,4	86,0	84,4	5,0	4,5	4,3	0,105	0,024	......	2	N W	Calm	S W	4	Cloudy	Cloudy	Fl. cl. Rainbow to the w. Th.
7	,836	,750	,812	82,8	86,4	85,3	4,3	7,4	3,3	......	......	......	2	W	W	S	4	Cloudy	Cloudy	Cloudy lightning.
8	,842	,750	,814	83,9	85,0	84,3	4,4	5,5	4,8	......	......	3,068	2	W	Calm	S W	7	Cloudy	Cloudy	Cloudy drizzling rain lightning.
9	,862	,790	,874	84,3	86,0	85,0	3,8	10,6	10,5	......	......	......	2,3	W N W	N W	W N W	8	Cloudy	Cloudy	Cloudy lightning.
10	,866	,780	,852	85,7	87,8	83,8	12,2	14,0	5,8	......	......	......	3	W N W	N W	N	9	T. haze	Cloudy	Cloudy drizzling rain lightning.
11	,850	,745	,812	85,5	88,0	84,5	8,5	15,0	9,9	0,005	......	......	4	W	W	N W	9	Cloudy	Cloudy	Cloudy lightning.
12	,756	—	,750	86,0	—	83,9	11,1	—	6,4	......	......	......	2,3	S W W	—	N	9	Cloudy	—	Cloudy do.
13	,786	,706	,802	87,2	91,3	89,2	11,6	15,8	7,4	......	......	......	2,3	S W W	N W by W	S	7	T. haze	Cloudy	Cloudy Rainbow to the east.
14	,878	,750	,854	88,6	92,0	86.8	13,2	13,5	8,0	......	0,345	......	2,3	W	S E	S W	6	T. haze	Cloudy	Th. hz. lightning. [strong wind.
15	,862	,738	,806	87,8	89,4	87,8	10,9	8,6	7,3	......	......	2,301	3	W	S S E	S	8	Haze	Cloudy	Th. hz. Th. and lightn. very
16	,816	,690	,790	85,5	89,7	84,8	5,7	8,7	6,3	1,214	0,147	......	2,3	S W	S	S W	7	Cloudy	Cloudy	Cloudy thunder and lightning.
17	,796	,724	,786	85,8	89,0	85,5	9,9	10,3	10,5	......	......	......	2,3	S W W	S. S E	S W	7	Cloudy	Cloudy	Cloudy lightning.
18	,806	,684	,798	86,9	90,3	85,9	10,5	12,6	7,3	......	......	......	2,3	S W	Calm	S W	8	Fl. cl.	Cloudy	Cloudy thunder and lightning.
19	,794	—	,783	85,3	—	82,7	6,8	—	2,1	0,557	0,035	......	2,3	S W	—	S W	8	Cloudy	—	Cloudy lightning.
20	,770	,688	,808	83,6	82,0	82,4	6,7	4,0	4,0	......	1,392	......	2	S W	N W.	S W	8	Cloudy	Cloudy	Cloudy do.
21	,796	,724	,810	81,7	83,2	81,7	5,5	6,2	5,2	0,467	......	......	2	S W	S. S W	S W	8	Cloudy	Cloudy	Cloudy do.
22	,806	,722	,804	81,9	86,2	84,1	6,5	9,2	6,6	......	......	2,131	2	S W W	S W	W	8	T. haze	Cloudy	Cloudy do.
23	,830	,710	,804	83,9	88,3	85,2	7,5	9,5	5,3	......	......	......	2,3	S W	S W	S W	8	T. haze	Cloudy	Cloudy do.
24	,814	,690	,790	85,2	90,2	85,9	9,4	14,2	6,4	......	......	......	3	W	S W	W	7	T. haze	Cloudy	Cloudy do.
25	,810	,706	,842	84,6	88,2	87,2	9,6	11,2	11,6	0,049	......	......	3	W	Calm	W	7	Cloudy	Cloudy	Cloudy do. strong wind.
26	,874	—	,846	86,6	—	89,2	12,1	—	10,2	......	......	......	2,3	W	—	N W	7	Haze	—	Haze do.
27	,886	,776	,850	87,7	90,8	88,6	8,4	15,8	14,3	......	......	......	2,3	W	W	W	7	Haze	Cloudy	Haze do.
28	,858	,744	,808	87,4	91,3	86,1	12,3	12,0	5,7	......	......	......	2,3	W N W	S E	S	5	Clear	Cloudy	Clear do.
29	,848	,733	,814	87,9	88,5	86,4	10,5	9,0	8,3	......	......	3,638	2,3	N W	S E	S	6	Clear	Cloudy	Cloudy do.
30	,830	,718	,808	86,8	89,0	88,3	7,9	11,6	7,8	0,067	......	......	2,3	W	S E	S	5	Haze	Cloudy	Fl. cl. do.
31	,848	,748	,850	88,4	88,0	86,2	12,0	8,5	5,2	......	......	......	2,3	W	S E	S	6	Haze	Cloudy	Fl. cl. do.
Mean.	29,836	29,738	29,821	85,7	88,4	85,8	8,6	10,2	7,1											

METEOROLOGICAL REGISTER KEPT AT THE MADRAS OBSERVATORY; FOR THE MONTH OF AUGUST, 1840.

Days.	Barometer at 10 A. M.	Barometer at 4 P. M.	Barometer at 10 P. M.	Ther. at 10 A. M.	Ther. at 4 P. M.	Ther. at 10 P. M.	Wet Bulb. 10 A. M.	Wet Bulb. 4 P. M.	Wet Bulb. 10 P. M.	Rain. Sun-rise.	Rain. Sun-set.	Evaporation.	Strength of wind.	Direction of Wind. 10 A. M.	Direction of Wind. 4 P. M.	Direction of Wind. 10 P. M.	Cloudy Max.	Weather. 10 A. M.	Weather. 4 P. M.	Remarks. 10 P. M.
1840	Inch.	Inch.	Inch.	o	o	o	o	o	o											
Aug. 1	29,870	29,748	29,874	86,2	92,0	85,8	10,3	15.0	6,4	......	0,117	......	2.3	W	S S W	S	7	Haze	Cloudy	Cloudy—Thunder and lightn.
2	,878	——	,850	85,5	—	85,9	7,6	—	5 9	0,909	......	......	2,3	W	——	S W	6	Clear	——	Cloudy th. and lightn. Rainbow
3	,854	,760	,848	85,0	86,0	83,1	8,0	8,0	5,6	......	......	......	2,3	W	W by N	S W	8	Cloudy	Cloudy	Cloudy lightn. [in the evening.
4	,838	,720	,798	85,4	88,0	85,6	6,9	10,0	7,1	......	......	......	2,3	W	swbyw	S W	6	Cloudy	Cloudy	Cloudy do.
5	,848	,734	,810	84,5	90,0	86,3	9,3	13,0	7,7	......	......	1,802	2,3	W	w by N	Calm.	6	Haze	Cloudy	Cloudy do.
6	,838	,704	,800	86,0	92,0	86,3	10,9	15,5	5,8	......	......	......	2,3	W	W S W	N W	7	Haze	Cloudy	Cloudy do.
7	,798	,700	,800	87,1	92,0	88,8	11,1	15,0	8,7	......	......	......	2,3	W	W	S E	6	Th. ha.	Cloudy	Cloudy do.
8	,858	,744	,856	86,9	93,0	88,6	7,4	16,0	7 7	......	......	......	2,3	W	W	S W	5	Th. ha.	Cloudy	Cloudy do.
9	,896	——	,856	87,2	—	87,4	10,3	—	4,4	......	......	......	2,3	W	——	S	4	Haze	——	Cloudy do.
10	,880	,748	,824	88,2	88,3	85,9	11,7	9,3	5,7	......	......	......	2,3	N W	S E E	S	3	Clear	Clear	Haze do.
11	,870	,774	,860	88,0	89,8	85,0	11,4	10,3	6,0	......	......	......	2,3	W	S S E	S	3	Fl. cl.	Clear	Haze do.
12	,890	,778	,888	86.9	89,0	85,8	9,6	8,5	6,3	......	......	3,628	2,3	N W	S E	S	5	Clear.	Clear	Fl. cl. do.
13	,912	,800	,888	87 9	88,8	87,9	8,4	7,0	6,9	......	......	......	2 3	W	S E	S	4	Clear	Clear	Fl. cl. do.
14	,908	,760	,848	86,1	90,0	87,0	7,4	10,0	5.5	......	......	......	2,3	S W	E	S	3	Clear	Clear	Th. hz. do.
15	,874	,774	,872	88,2	90,0	88,2	12,6	10,0	6.1	......	......	......	2,3	N W	S E	S	4	Haze	Haze	Th. hz. do.
16	,910	,830	,912	89,0	90,0	88,2	13.0	10,0	6,7	......	......	......	2,3	W	S E	S	4	Haze	Haze	Fl. cl. do.
17	,910	,780	,852	89,0	90,0	87,9	11,0	9,5	6.8	......	......	......	2,3	S W	S.S W	S	8	Haze	Haze	Th. hz.—vivid lightning.
18	,880	,764	,856	84,9	89,4	86,4	7,4	9,6	5,3	......	......	......	2,3	N W	E	S	7	Cloudy	Cloudy	Cloudy lightning.
19	,864	,788	,832	86,4	88,2	86,8	11,0	8,7	6,5	......	......	3,026	2,3	W	E by S	S	5	Th. ha.	Cloudy	Cloudy do.
20	,890	,802	,856	86,5	89.0	85,7	10,5	9,3	5,7	......	......	......	2,3	N W	E by S	S E	5	Th. ha.	Cloudy	Clear do.
21	,896	,784	,870	87,2	88,8	87,7	9,0	9,5	7,2	......	......	......	2,3	W	E S E	S	7	Th. ha.	Clear	Fl. cl. do.
22	,876	,763	,854	87,7	89,2	86,8	8,6	9,2	7,9	......	......	......	2,3	S W	——	S	4	Fl. cl.	Clear	Cloudy drizzling rain & lightn.
23	,878	——	,850	85,3	—	86,7	5,9	—	3,1	0,437	......	......	2,3	S W	E by S	W	6	Fl. cl.	——	Clear lightning.
24	,892	,774	,922	85,5	88,0	85,1	6,5	7,0	4,7	......	......	......	2,3	W	S E	S E	7	Clear	Clear	Cloudy do.
25	,904	,783	,856	85,0	88,2	87,0	2,5	7,7	4.4	0,287	......	......	2,3	W	S	S E	4	Haze.	Cloudy	Cloudy vivid lightning.
26	,878	,743	,822	83,6	88,7	85,9	5,8	7,7	5,1	0,027	......	2,331	2,3	W	E	S E	6	Cloudy	Th. hz.	Haze lightning.
27	,854	,736	,842	85,4	88,0	87,3	6,4	7,0	5.8	......	......	......	2,3	S W	S	S	8	Haze.	Clear	Haze loud th. & vivid lightn.
28	,888	,762	,862	82,0	87,0	85,9	5,5	5,5	4,4	3,952	......	......	2,3	W	E S E	S	6	Cloudy	Clear	Cloudy do. do. do. do.
29	,866	,758	,854	83,2	86,0	84,8	4,2	5,5	3,4	2,091	......	......	2,3	N W	——	S	6	Cloudy	Cloudy	Haze lightning.
30	,824	——	,802	84,1	—	84,2	4,9	—	4,3	......	......	......	2,3	N E	S E	E	8	Cloudy	——	Haze do.
31	,800	,684	,822	84,8	86,0	82,6	4,3	5 0	4,2	......	......	......	2,3	S W	Calm	W	8	Fl. cl.	Cloudy	Rainy loud th. & vivid lightn.
Mean	29,872	29,759	29,851	86,0	89,1	86,4	8,4	9,6	5,8											

South-east Portion
of the
GREAT BASALTIC DISTRICT
of
INDIA.
to illustrate Mr. Malcolmson's memoir.
Diamond Sandstone. Argillaceous Limestone
Granite & Gneiss.
Mica, Chlorite & Hornblende Slates
Basalt
Laterite.
Alluvium.
75
76
77
78
79
80
81
82
21
20
19
18
17
16
15
Gawilgur (Fossils)
Narnulla
Ellichapoor
Oomrawutty
Ramteak
Kamptee
NAGPOOR
Kanhan R.
Goomigaum
Takulghaut
Sindee
Mahangaum
(Fossil Wood)
Hingan-ghat
Naugree (Fossil Shells)
Wurda R.
Wurroorah
Banduck
Chandah
Wonor Wunny
Hot Springs
Rajoorah
Sangaree
Adilabad
Beroor
Chicholy
Hutnoor
Echodah
Surpoor
Mundwah
Bibberee
Waddoorpett
Andkee
Kurrum R.
Soorarum
NIRMUL
Doodgaum
Godavery R.
Cotapilly
Sironcha
Balcondah
Chinnoor
Hurroolah
Indoor
Dekarapully
Ramgheer
Lankulagud
Kunamulla
(Petrified Wood)
Perricapoor
Nagarum
Mulloopettah
Nuggur
Kamahred
Elgundel
Mullangoor
Bungapoor
Mungapett
Rajampetta
Byaram
Munnugore
Bekanoorpella
Maiduck
Narsingumpett
Doopranee
Medecondah
Waringole
Byorah or Boilgah (Hot Spring)
Ashwapoorum
Badrachellum (Hot Spring)
Yellumpettah
Palensha
Gopaulrowpett
Papcondah
Ahmedhal
Bougheer
Bolarum
Secunderabad
Neercondah
HYDERABAD
Mussy R.
Golcondah
Gungarum
Dummapait
Gummamet
Shumshabad
Nelgoondah
Sooriapett
Chintalapoody
Gokdrum
Fossil Oysters
Rajahmundry
Ramsingarum
Juddacherlah
Dewurcaudry
Warrapilly Ghaut
Nundicamah
ELLORE
Condapilly
(Diamond Mines)
Bezwarrah
Amarawutty
Madapollam
Kistna R.
Ruckputtypett
Paungul
Tentelly
GUNTOOR
MASULIPATAM
Innaconda
Ongole
Cumbum
Copper Mines
Paumoor
Nulla Mulla Hills
Nundyall
Bangnapilly
Junction of Sections 1 & 2
Jummulmudgoo
Gundycottah
Penaur R.
Diamond Mines
CUDDAPAH
NELLORE
Section 2
Section 1
Ryachottee
Durmawaram
Niddigul
Cuncoopa
GOOTYDROOG
BELLARY
Adonie
KURNOOL
Toombudra R.
Ranchoor
Muctul
Yeedgherry
Gulburgah
BEEJAPOOR
MOODGUL
Gudjunterglour
Kulladghee
Belgaum
Nargoond
Noulgoond
Darwar
Hullial
Yellapoor
Savanoor
Soonda
Honhully
CHITTLEDROOG
Tapti R.
Poornah R.
Ackolah
Mallegaum
Adjuntah
Karinjah
Payne Gunga R.
Jafferabad
Baussum
Ellora
AURUNGABAD
Jaulnah
Lonar
Rishwur
Tulnee
Hingolee
Julny
Oomerkair
Partoor
Ahoondah
Goongee
Poornah R.
Busmunt
Wurhona
Sichel or Nirmul Hills
Nandair
Godavery R.
Beer
Khair
Dharoor
Oodgheer
Owsah
Manjerah R.
Kowles
BEDER
Vyrag
Sholapoor
Seena R.
Punderpoor
Bheema R.
Transfer by J. Dumphy.
Printed by W. Winchester.

BRITISH MUSEUM
NATURAL HISTORY

Madras Jour. Lit. & Science, Vol XII, Pl. VI.

Section 1.

Section 2.

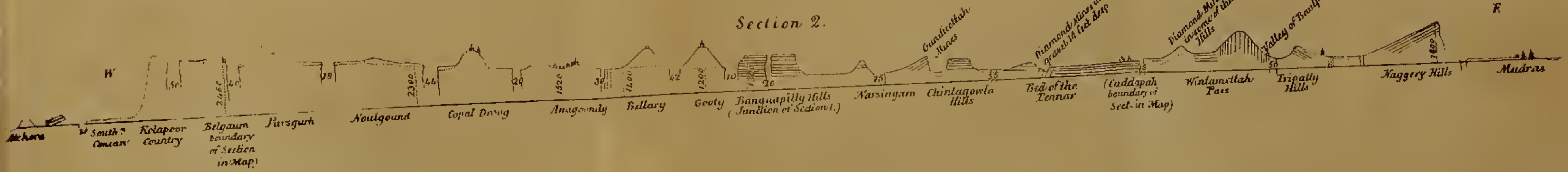

Table Land of Bangnapilly

Diamond Mines in Alluvium

BRITISH MUSEUM
NATURAL HISTORY

SOUTHERN INDIA.
(See Mr Malcolmson's Memoir.)

Dumphy & Winchester, Lith.